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Managing Ground Water Contamination Sources in Wellhead Protection Areas: A Priority Setting Approach

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13. Abstract This document is one of a series of technical assistance documents designed by the U.S. EPA to help local governments and public water suppliers protec t their wells and implement their state and local Wellhead Protection Programs. This priority setting approach provides a risk screening tool that helps users to assess and rank the relative threats to ground-water supplies posed by specific potential contamination sources.

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A Priority Setting Approach

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MANAGING GROUND WATER CONTAMINATION SOURCES IN WELLHEAD PROTECTION AREAS: A PRIORITY SETTING APPROACH

Office of Water
U.S. Environmental Protection Agency

October 1991

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EXECUTIVE SUMMARY

The 1986 Amendments to the Safe Drinking Water Act established a new Wellhead Protection Program for ground waters that supply drinking water to public systems. *Managing Ground Water Contamination Sources in Wellhead Protection Areas: A Priority Setting Approach* is one of a series of technical assistance documents designed by the U.S. Environmental Protection Agency to help local governments and public water suppliers protect their wells and implement their state and local Wellhead Protection Programs.

This Priority Setting Approach provides a risk screening tool that helps users to assess and rank the relative threats to ground-water supplies posed by specific potential contamination sources that fall into any of the following major source categories: Agrichemical Application, Container Storage and Material Transfer, Injection Wells: Deep Wells (Classes I, II, and III), Injection Wells: Shallow Wells (Class V), Land Treatment, Landfills, Material Transport, Pipelines, Septic Tank Systems, Storage Piles, Surface Impoundments, and Tanks.

This Approach allows the estimation of the human health risks posed by a contamination source. The user calculates a risk score for each potential contaminant by multiplying two components of risk:

- **Likelihood of Well Contamination:** the probability that the contaminant will be released from the source and will reach the well within a user-specified planning period. This is a function of two risk elements: *Likelihood of Release at the Source* (how likely is it that the contaminant will be released from the source into the soil underlying the source) and *Likelihood of Reaching the Well* (if the contaminant is released, how likely is it to reach the well within the planning period?).

- **Severity of Well Contamination:** For a given contaminant at a given source, the Severity of Well Contamination is the carcinogenic or non-carcinogenic risk to an individual drinking water from the well in the event contaminants are released and reach the well. This is a function of three risk elements: *Quantity* released at the source (what is the amount of contaminant expected to be released from the source?), *Attenuation* due to transport (what fraction of the contaminant released will reach the well and at what concentration?) and *Toxicity* (how toxic is the contaminant? For carcinogens, the lower the concentration of a chemical resulting in a 10^{-5} lifetime risk, the higher the toxicity of that chemical. For non-carcinogens, the lower the concentration threshold of a chemical (the point above which adverse health effects are exhibited), the higher the toxicity of that chemical.

This Approach allows the user to compare the Likelihood and Severity of well contamination from one source, as well as the Likelihood and Severity of well contamination from different sources. The overall risk score for a given source is the highest of the risk scores associated with all contaminants present at the source.

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CHAPTER 1: INTRODUCTION

Managing Ground Water Contamination Sources in Wellhead Protection Areas: A Priority Setting Approach is one of a series of technical assistance documents designed to help local governments and public water suppliers protect their wells and implement their state and local Wellhead Protection Programs. The purpose of this Approach is to assess the relative threats to ground-water supplies from different contamination sources.

The 1986 Amendments to the Safe Drinking Water Act (SDWA) established a new Wellhead Protection Program to protect ground waters that supply drinking water to public water supply systems. This program requires the participation of all levels of government.

The federal government is responsible for approving state Wellhead Protection Programs and for providing technical support to state and local governments. States must develop and implement programs that meet the requirements of the SDWA Amendments. At a minimum, a state's Wellhead Protection Program must:

- specify the roles of the state and local entities with wellhead protection duties
- delineate the wellhead protection area (WHPA)* for each well
- develop management approaches to protect each WHPA
- develop contingency plans to respond to well or wellfield contamination
- site new wells properly to minimize potential contamination
- ensure public participation in the program.

Because localities are often in the best position to implement measures to ensure that individual wells and wellfields are properly protected from contamination, the U.S. Environmental Protection Agency has prepared this manual for use at the local level.

This manual can help local users evaluate and rank the risk to their public water supply from potential contamination sources in their wellhead protection areas. While it is important to manage all sources within a WHPA, it is sometimes necessary for communities to prioritize their activities. In addition to providing an approach to risk screening, this manual can be helpful in making siting decisions, in evaluating the relative risk of different design factors, and in assessing the general vulnerability of a WHPA.

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* A wellhead protection area is defined as "the surface and subsurface area surrounding a water well or wellfield, supplying a public water system through which contaminants are likely to move toward and reach such well or wellfield" (ref. 47). The extent of the protection area is determined by state guidelines in states with approved programs.

ABOUT THIS MANUAL

What Is the Priority Setting Approach?

This Approach is a risk screening tool that will enable you to assess the risks posed by specific potential sources of contamination. Risk screening is a simplified form of risk assessment that uses limited data to yield a relative expression of risk. Using this Approach, you will be able to assess potential sources of contamination that fall into any of the following major source categories:

1. Agrichemical Application
2. Container Storage and Material Transfer
3. Injection Wells: Deep Wells (Classes I, II, and III)
4. Injection Wells: Shallow Wells (Class V)
5. Land Treatment
6. Landfills
7. Material Transport
8. Pipelines
9. Septic Tank Systems
10. Storage Piles
11. Surface Impoundments
12. Tanks.

Who Is This Manual Intended For?

This manual is designed to be used by local managers such as city planners, water supply superintendents, and local health and environment department officials. You do not need computer or modeling experience, nor will you require extensive training or study before you can use this manual.

How Can It Help You?

When managers are assessing the threats to public water supply, it is often difficult to determine which of the many potential contamination sources poses the greatest risk to a well. Although it is possible to conduct detailed risk assessments of all the potential sources, such assessments require a large amount of information and extensive resources that are not generally available to managers at the local level.

This manual addresses these concerns by allowing you to screen potential contamination sources on the basis of risk, using readily available information. It thus helps local managers to prioritize their management efforts as well as explain their actions to the public.

What Will It Do?

This manual will help you determine a risk score for each potential source of contamination. Based on the risk scores, you will be able to:

- **Rank** sources (assess whether one source poses a greater risk than another source)
- **Screen** sources (determine whether a given source poses a high, medium, or low level of risk).

What Won't It Do?

There are limits to the ranking and screening capabilities of this Approach which need to be kept in mind. It is *not*:

- a substitute for site-specific, detailed risk assessments
- a comprehensive screening system for all possible contamination sources or contaminants, or all possible routes of exposure to contaminants (ingestion is the only route considered)
- a technique for analyzing management approaches.

What Is Needed to Use This Manual?

To use this manual, you will need to have on hand, or have access to, basic information about the location of the well, the WHPA, and the potential contamination sources; the WHPA hydrogeology; and the characteristics of the potential sources of contamination. The following chart summarizes the information needed to use this manual.

Major Information Needs		
Locational Information	**Hydrogeology and Well Information**	**Source-Specific Information**
▸ map showing the wellhead protection area boundaries ▸ map showing the location of potential contamination sources	▸ depth to the aquifer ▸ aquifer thickness ▸ type of soil above the water table (e.g., silt or sand) and aquifer material (e.g., sand or gravel)	▸ basic design features (e.g., type of landfill liner) ▸ distance from well ▸ contaminants present (defaults provided)

What Does the Priority Setting Approach Assume?

As you use this manual, you need to ensure that your WHPA and your sources satisfy the assumptions built into this Approach; if they differ substantially from these assumptions, you will not be able to use this manual for screening and ranking sources in your WHPA. Some of the major assumptions and limitations built into this Approach are summarized below:

- **Hydrogeologic Characteristics.** The hydrogeologic characteristics in the WHPA are assumed to be relatively homogeneous and isotropic. In other words, it is assumed here that you can characterize the WHPA by one average value for each of the following parameters: depth to aquifer, aquifer thickness, hydraulic conductivity in the unsaturated zone, and ground-water velocity. *If the hydrogeologic characteristics vary significantly within your WHPA, you cannot use this manual to rank and screen potential contamination sources.*

  For example, if the depth to the aquifer is 10 feet under source A and 150 feet under source B, then you cannot use this Approach as it is currently configured because it assumes one average value for depth to aquifer.

- **Hydrogeologic Setting.** One of four basic hydrogeologic settings is assumed:

  -- surface source overlying a water table aquifer
  -- deep source (Class I, II, and III injection wells) with accidental releases in a confined aquifer

-- surface source in a recharge area of a confined aquifer
-- surface source overlying a confined aquifer.

- **Zone of Contribution.** It is assumed that the contaminants released from each source inside the WHPA can reach the well. This Approach does not distinguish explicitly between sources that are upgradient from the well and sources that are downgradient from the well. Thus, this Approach may overestimate risks posed by sources that are downgradient from the well because these contaminants can be expected to flow away from the well.

- **Carcinogenic and Non-Carcinogenic Risks.** You can use this manual to screen and rank sources based on carcinogenic and non-carcinogenic risks, either together (only one risk score for each source) or separately (two risk scores for each source). It has a built-in formula so that it is not necessary to consider carcinogenic and non-carcinogenic sources separately. Specifically, this Approach equates a 10^{-5} (1 in 100,000) cancer risk with a lifetime exposure to the reference dose for non-carcinogens. Other environmental programs use different levels of acceptable cancer risk. Most commonly, they range from 1 in 10,000 (10^{-4}) to 1 in 1,000,000 (10^{-6}). For information on how to modify this assumption, see Technical Appendix A.

- **Human Exposure.** This manual assumes that human populations will be exposed to the contaminants released by potential sources only through the consumption of contaminated drinking water. It does not consider exposure to contaminants through any other pathways such as inhalation or dermal contact.

For a more detailed discussion of the assumptions and limitations, and the hydrogeological settings used in this manual, please refer to Technical Appendix A.

How Does the Priority Setting Approach Work?

As a risk screening tool, this Approach relies on the general principles of risk assessment, but requires less data and provides a less rigorous analysis than a formal risk assessment. It integrates information from several EPA data bases and models such as the IRIS data base for toxicity information, the RCRA Risk-Cost Analysis Model (or WET model), the Liner Location Model, and the Hazardous Waste Tank Failure model for information on the potential for contaminant release.

This Approach allows you to estimate the human health risks posed by a contamination source. You obtain the risk score by multiplying two risk components:*

- **Likelihood of Well Contamination** and
- **Severity of Well Contamination** in the event contaminants are released and reach the well.

For a given contaminant at a given source, the Likelihood of Well Contamination is the probability that the contaminant will be released from the source and will reach the well within the planning period you specify (e.g., 10 years). The Likelihood of Well Contamination (L) is a function of two risk elements:

1. **Likelihood of Release at the Source** (L1), that is, how likely is it that the contaminant will be released from the source into the soil underlying the source?

2. **Likelihood of Reaching the Well** (L_2), that is, if the contaminant is released, how likely is it to reach the well within the planning period of interest?

For a given contaminant at a given source, the Severity of Well Contamination is the carcinogenic or non-carcinogenic risk to an individual drinking water from the well. The Severity of Well Contamination (S) is a function of three risk elements:

1. **Quantity** released at the source (Q), that is, what is the amount of contaminant expected to be released from the source?

2. **Attenuation** due to transport (A), that is, what fraction of the contaminant released will reach the well and at what concentration?

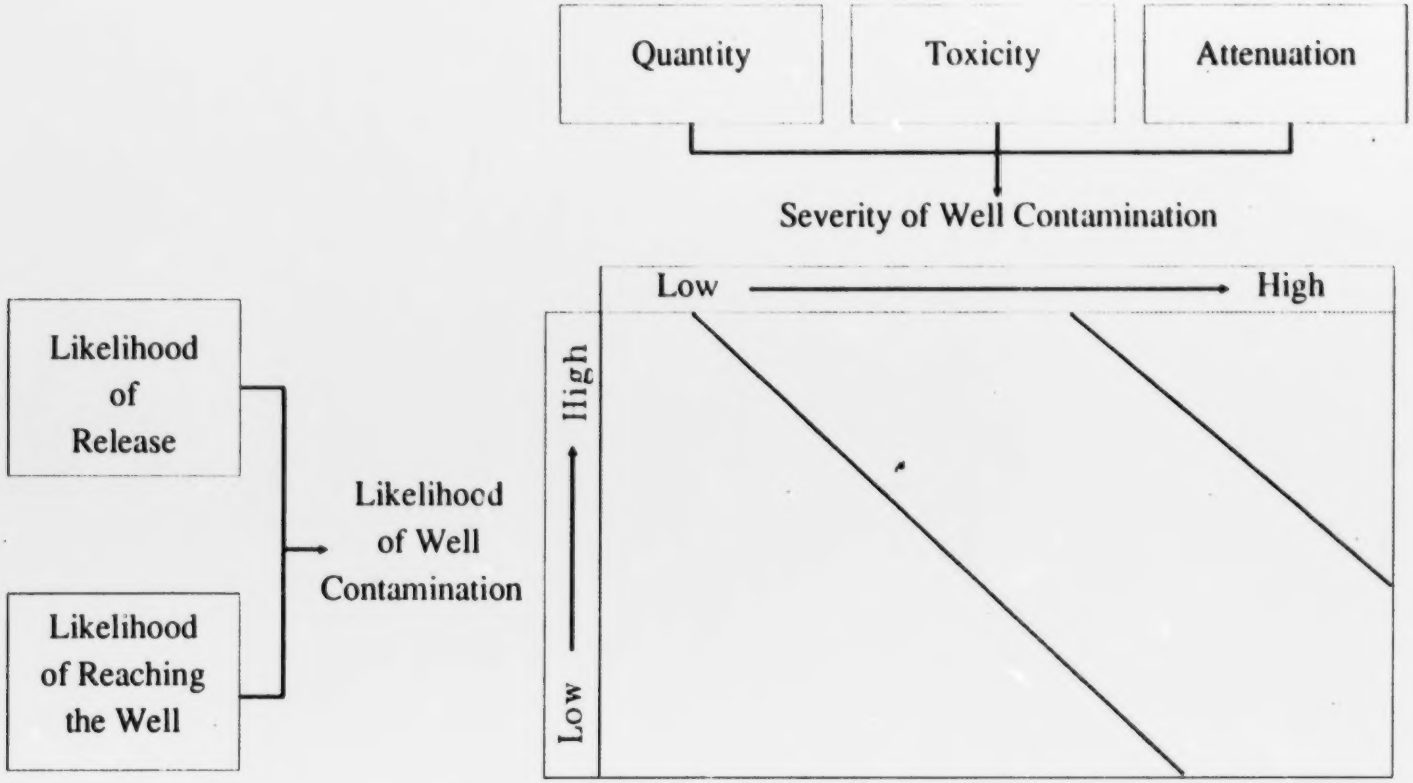
3. **Toxicity** (T), that is, how toxic is the contaminant? For carcinogens, the lower the concentration of a chemical resulting in a 10^{-5} lifetime risk, the higher the toxicity of that chemical. For non-carcinogens, the lower the concentration threshold of a chemical (the point above which adverse health effects are exhibited), the higher the toxicity of that chemical.

The scores for each of these risk components can be plotted on a conceptual diagram of the Risk Matrix shown in Exhibit 1. This exhibit enables you to visualize the relationship

* For a further explanation of this equation, see "A Note on Negative Scores" on page 29.

Exhibit 1

Conceptual Diagram of the Risk Matrix



between the Likelihood and Severity of Well contamination from one source, as well as to compare the Likelihood and Severity of Well contamination from different sources.

The overall risk score for a given source is the highest of the risk scores associated with all contaminants present at the source. Technical Appendix B provides a conceptual overview of this process.

How Can the Results Be Used?

You can use the results of this Approach to assist in management activities, including:

- prioritizing source management efforts (e.g., site inspection, monitoring, enforcement, education, data collection)
- planning and zoning aimed at controlling the siting of new potential contamination sources
- conducting vulnerability assessments under the Public Water Supply Supervision Program.

THE ORGANIZATION OF THIS MANUAL

This manual contains all of the guidance, datasheets, and worksheets necessary to systematically perform a site-specific risk screening and ranking of contamination sources in 12 major source categories. The remainder of this manual is organized as follows:

Chapter 2: User's Guide

This chapter provides you with general guidance on completing five major tasks necessary to characterize the risk posed by the contamination sources. These tasks are to: (1) characterize the WHPA, (2) characterize the potential contamination sources, (3) perform source-specific calculations, (4) perform transport calculations, and (5) estimate risks and rank sources. You complete these tasks by filling out the datasheets, worksheets, master scoresheet, and risk matrix contained in Chapters 3 and 4 of this manual. This chapter also presents a hypothetical example of the applying this Approach.

Chapter 3: Master Scoresheet, Risk Matrix, Wellhead Datasheet, and Contaminant Forms

This chapter contains the sheets that you will fill out to assess the WHPA. Also contained in this chapter are the contaminant forms. These forms provide information you will need for scoring the toxicity, mobility, and persistence of the contaminants associated with each source category.

Chapter 4: Source Datasheets, Source Worksheets, and Transport Worksheet

This chapter contains the datasheets and worksheets that you will fill out for each source that is evaluated. Datasheets and worksheets are included for the following major contamination source categories, listed in alphabetical order:

1. Agrichemical Application
2. Container Storage and Material Transfer
3. Injection Wells: Deep Wells (Classes I, II, and III)
4. Injection Wells: Shallow Wells (Class V)
5. Land Treatment
6. Landfills
7. Material Transport
8. Pipelines
9. Septic Tank Systems

10. Storage Piles
11. Surface Impoundments
12. Tanks.

This chapter also contains the Transport Worksheet. This worksheet must be completed once for each source in order to evaluate the fate and transport of contaminants released by that source.

Appendices

The remainder of this manual contains two technical appendices, references, and a glossary. Technical Appendix A presents a detailed discussion of the assumptions and limitations of the Priority Setting Approach, and Technical Appendix B provides a conceptual overview of this Approach and its risk scoring system. The glossary of technical terms can assist readers who may not be familiar with all of the terms used in this manual.

CHAPTER 2: USER'S GUIDE

This chapter describes the basics of this Priority Setting Approach. The introductory section presents an overview of this Approach's five tasks, and describes how to use the datasheets and worksheets. It also describes the default values provided for certain parameters in the datasheets and worksheets. You can use these average values when site-specific values are difficult to obtain. The next section provides general guidance on how to complete each of the five tasks and the specific steps to be taken under each task. The last section presents a hypothetical example of how to apply this Approach.

This manual is organized in chapters that can be removed from this binder to permit easier access to the data contained in other sheets. You should read this chapter (the User's Guide) at least once to familiarize yourself with this Approach before you begin completing the sheets in Chapters 3 and 4.

USING THE PRIORITY SETTING APPROACH

This Priority Setting Approach contains five major tasks; within these tasks are 12 specific steps. When working through the tasks, you will complete a wellhead datasheet, source datasheets and worksheets, and transport worksheets. These datasheets and worksheets, in turn, will be used to complete a master scoresheet and finally, the risk matrix.

Tasks You Need to Perform

This manual helps you to evaluate the risks posed by potential sources of well contamination by guiding you through the following tasks:

Task I Characterize Your WHPA

Task II Identify and Characterize Potential Sources of Wellhead Contamination in Your WHPA

Task III Perform Source Calculations

Task IV Perform Transport Calculations

Task V Estimate Risks and Rank Sources

In Task I, you will locate your WHPA on a map and characterize its hydrogeology. In Task II, you will identify all potential sources of wellhead contamination (e.g., landfill, storage pile) in your WHPA and characterize each source by a number of elements including its design, age, distance from the well, and contaminants or contaminant mixtures present (including toxicity). In Tasks III and IV, you will estimate the following risk elements *for each contaminant or contaminant mixture present at each potential source:*

- the likelihood of the contaminant/mixture being released and the quantity of contaminant/mixture released (Task III)
- the likelihood that the contaminant/mixture will reach the well if it is released, and its attenuation (the fraction of the contaminant/mixture that will reach the well after dilution and/or chemical breakdown) (Task IV).

In Task V, you will estimate the risk posed by each potential source of well contamination by aggregating the contaminant-specific elements of risk estimated in Tasks III and IV. This will allow you to rank and screen the potential sources of well contamination in your WHPA on the basis of risk.

Using the Datasheets and Worksheets

To perform the five tasks, it is necessary to complete datasheets, worksheets, a master scoresheet, and a risk matrix. In addition, contaminant forms are provided to help you fill out the datasheets.

- **Datasheets.** Two types of datasheets are provided. The *Wellhead Datasheet* is used to characterize the hydrogeology within your WHPA (Task I) and as a reference in completing Tasks III and IV. A *Source Datasheet* is provided for each of the 12 source categories. It is used to characterize the source (Task II) and as a reference in Tasks III and IV.

- **Contaminant Forms.** These forms provide contaminant-specific information necessary to complete the contaminant data tables contained in all of the Source Datasheets. They do not need to be filled out; rather, they are used as a reference in completing the datasheets in Task II.

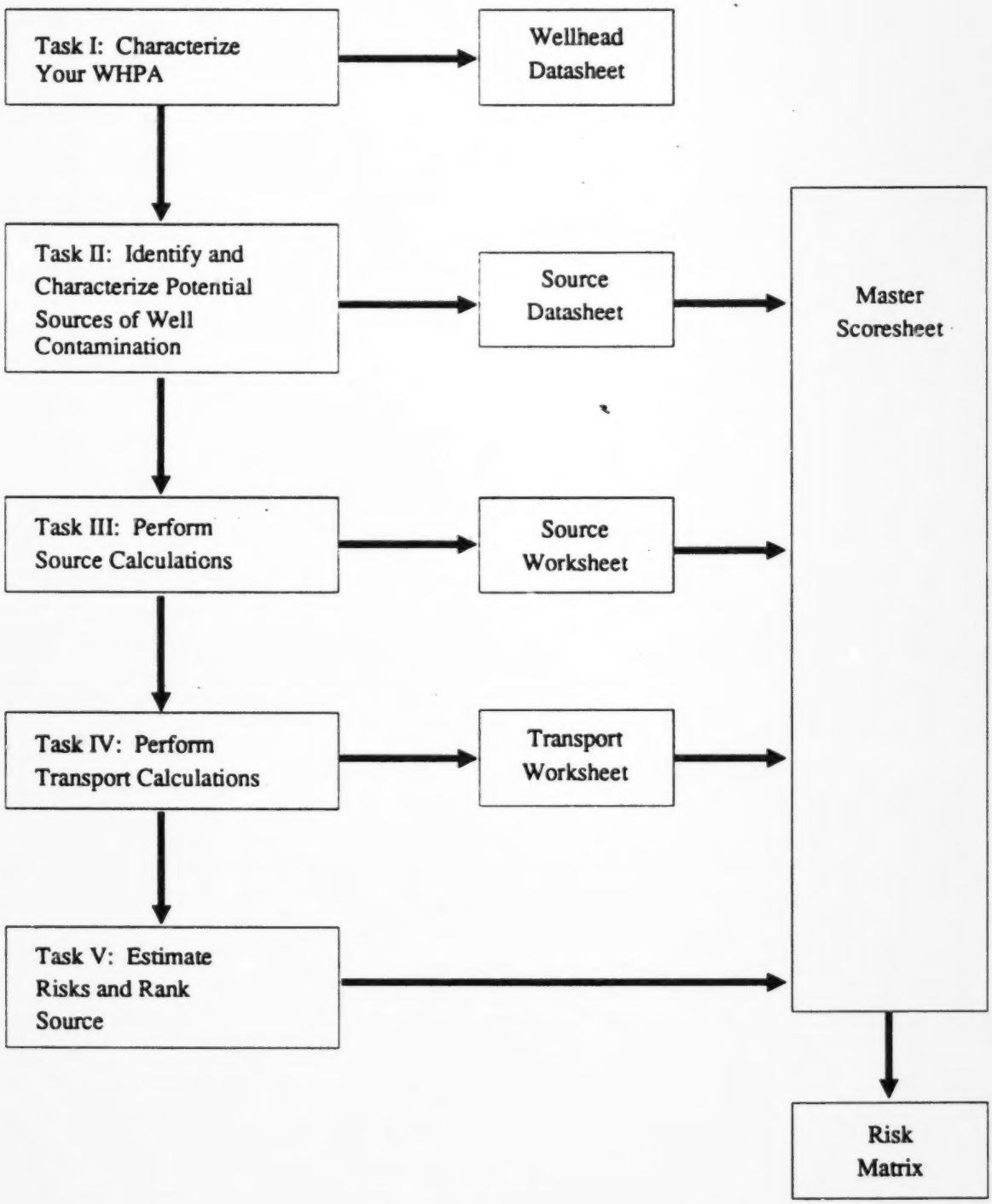
- **Worksheets.** Two types of worksheets are provided. One *Source Worksheet*, like the Source Datasheet, is provided for each source category. It is used to determine the likelihood that a contaminant/mixture will be released and the expected quantity released (Task III). The *Transport Worksheet* is used to determine the likelihood that the contamination will reach the well and the attenuation of the contaminant (Task IV).

- **Master Scoresheet.** This scoresheet compiles the information gathered in Tasks II through IV in order to estimate risks and rank the sources.

- **Risk Matrix.** This matrix allows you to estimate the human health risks posed by the contaminants at each source (Task V). You will complete the Risk Matrix using the information in the Master Scoresheet to plot the likelihood of well contamination against the severity of well contamination.

Exhibit 2 illustrates the use of these sheets by task. An example of how to use these sheets is given on page 15.

Exhibit 2
Using the Datasheets and Worksheets by Task



Example of Using Datasheets and Worksheets

Assume that you are estimating the risk posed by a landfill located within your WHPA. You will first complete the Wellhead Datasheet to characterize the hydrogeology of your WHPA (Task I). Note that you will need to perform this first task only once, regardless of how many sources you have in your WHPA. You will then report the name of your landfill and assign it an identification number in Block I of the Master Scoresheet, and characterize the landfill by completing the Landfill Datasheet (Task II). To complete this datasheet, you will refer to the contaminant forms. Next, you will complete the Landfill Worksheet (Task III) and the Transport Worksheet (Task IV) for your landfill, and report the estimates of the risk elements in Block II of the Master Scoresheet. Finally, you will estimate the risk posed by your landfill by completing Block III of the Master Scoresheet, and plot the risk scores of the landfill on the Risk Matrix (Task V). For a complete illustration of how to use these sheets, see the example provided in the last section of this chapter.

Exhibit 3 summarizes the sheets used in each task and the chapters in which they are located. It highlights the sheets that need to be completed in each task (task sheets) and the sheets that you need to refer to in each task (reference sheets).

As this exhibit shows, you will often use Chapters 3 and 4 simultaneously. In Task IV, for example, you will need information from the Wellhead Datasheet, which is contained in Chapter 3, and the Source Datasheet, which is contained in Chapter 4. These will be used to complete the Transport Worksheet, which is also contained in Chapter 4. In addition, you will sometimes need to move back and forth between sheets. For example, as you complete the Transport Worksheet for one source, you will need information from the corresponding Source Datasheet, both of which are contained in Chapter 4.

Exhibit 3
Tasks and Their Associated Sheets and Locations

Task	Reference Sheets (provide information to perform the task)		Task Sheets (sheets completed in order to perform the task)	
	Name	Location	Name	Location
I. Characterize Your WHPA	--	--	Wellhead Datasheet	Chapter 3
II. Identify and Characterize Potential Sources of Well Contamination	Contaminant Forms	Chapter 3	Master Scoresheet Source Datasheets	Chapter 3 Chapter 4
III. Perform Source Calculations	Wellhead Datasheet Source Datasheets	Chapter 3 Chapter 4	Source Worksheets Master Scoresheet	Chapter 4 Chapter 3
IV. Perform Transport Calculations	Wellhead Datasheet Source Datasheet	Chapter 3 Chapter 4	Transport Worksheet Master Scoresheet	Chapter 4 Chapter 3
V. Estimate Risks and Rank Sources	--	--	Master Scoresheet Risk Matrix	Chapter 3 Chapter 3

A NOTE ON COPYING THE DATASHEETS AND WORKSHEETS

Before you fill out these sheets, you should make as many photocopies of them as you need in order to evaluate all of your sources.

- **Wellhead Datasheets.** Make one copy for each WHPA.
- **Transport Worksheets.** Make as many copies of these worksheets as there are sources in your WHPA.
- **Source Datasheets and Source Worksheets.** For each source category (e.g., landfills and septic tanks), have as many copies of these sheets as there are sources in that source category. Thus, if your WHPA has three septic tanks systems and one landfill, you will need three Source Datasheet/Worksheet sets for septic tanks and one set for the landfills. If you can group clusters of the same sources (e.g., a block of houses using septic tank systems), you will need to copy only one set for that source.
- **Master Scoresheet.** Make as many copies as you need to list all of your sources in all of your WHPAs.

You do not need to make additional copies of the other sheets.

Using Defaults

The datasheets and worksheets provide default values for certain parameters. Default values are average values that you may use if site-specific data are difficult to obtain. Depending on the situation, the difference between a default value and the actual, site-specific data can be significant. *Thus, whenever possible, you should gather site-specific data rather than use default values; this will ensure that you are developing a more accurate representation of your sources.*

If you are not sure which default value to use in a range of possible values, it is wise to choose the value that will result in a higher Likelihood or Severity score in order to err on the side of over-estimating risk. In this way, you will ensure that you have protected the public from the greatest risks potentially posed by a source. If you choose a default value that errs on the side of over-estimating risk and that source finishes with a medium or high Risk score, however, you should check the sensitivity of the risk result to that parameter. To do this, redo

all the calculations for that source by replacing the conservative default value with a median default value. If the final ranking of the source changes dramatically (for example, if the source moves from a medium or high risk to a low risk), then you should make every effort to gather more accurate, site-specific data for that parameter in order to determine a better risk estimate for that source.

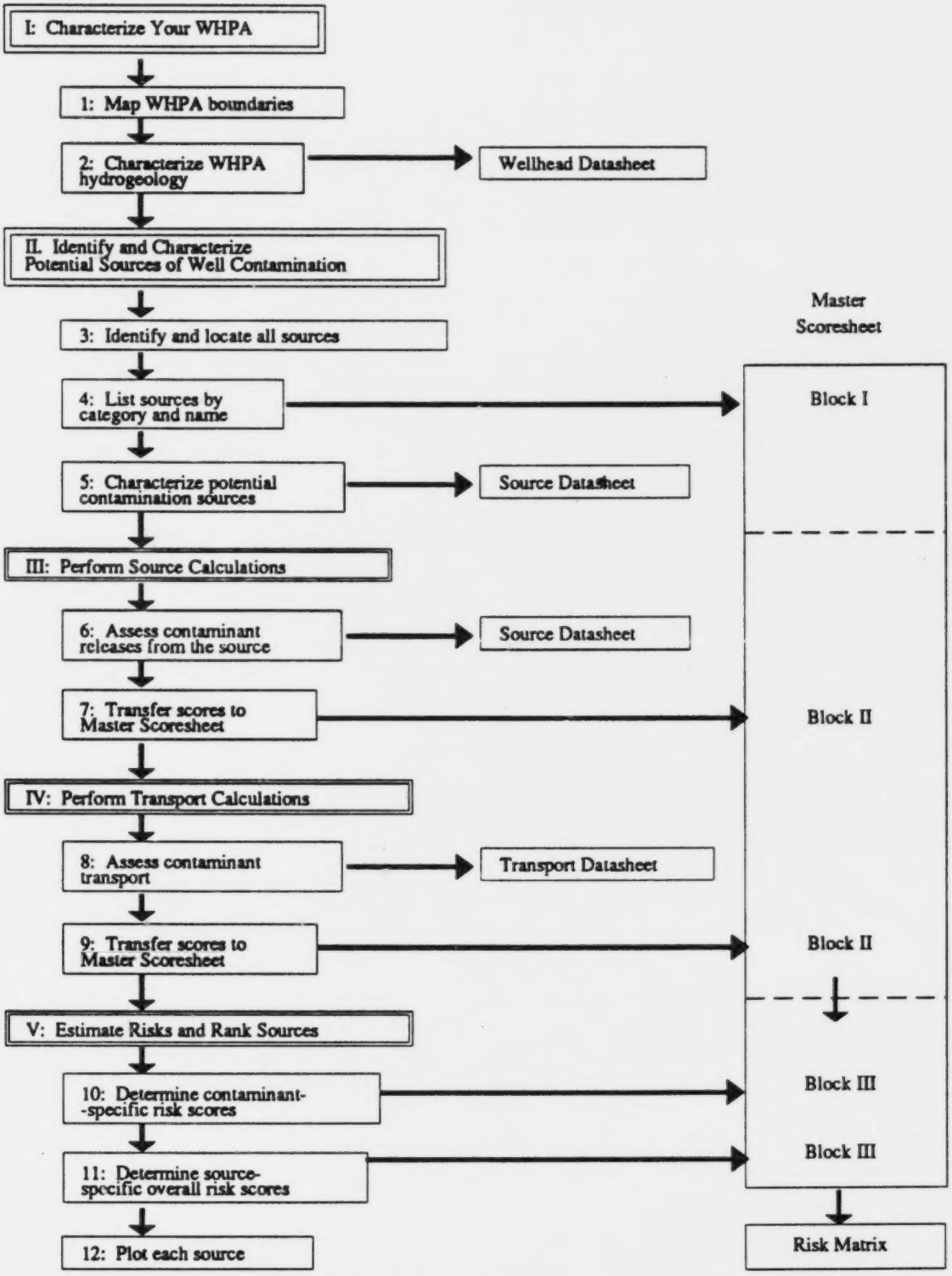
Last, if the datasheets and worksheets do not provide a default value for a given parameter and no site-specific data are available for that parameter, you may want to consult with other officials or industry representatives who may have that information. If you are still unable to obtain a range of possible values for that parameter, then you cannot use the Priority Setting Approach.

GENERAL GUIDANCE FOR EACH TASK

Within each of the five tasks are two or three steps that you must perform in sequence in order to complete the task. There are a total of 12 steps for the five tasks. Exhibit 4 provides an overview the tasks and steps contained in this Approach.

This section provides general guidance on how to complete the Priority Setting Approach. The guidance given here is not comprehensive. Instead, it is intended to give basic instructions, to help you with those steps requiring decisions and judgment, and to provide you with sources of additional information. More specific instructions on how to complete each step are contained in the datasheets and worksheets in Chapters 3 and 4. The hypothetical example of using this Approach, which is presented in the next section, will also assist you in completing this Approach.

Exhibit 4
Overview of the Priority Setting Approach



Task I: Characterize Your WHPA

Steps	Name and Location of Data Entry Sheets
1. Map WHPA boundaries	
2. Characterize WHPA hydrogeology	Wellhead Datasheet (Chap. 3)

Step 1 Guidance: Map WHPA Boundaries

- Identify the boundaries of your WHPA on a map. It is assumed here that all contaminants introduced within the boundaries of the WHPA could reach the well. For more information on delineating WHPAs, see: U.S. Environmental Protection Agency, Office of Ground-Water Protection, *Guidelines for Delineation of Wellhead Protection Areas*, Washington, D.C., 1987. Before determining which delineation method to use for your WHPA, check with your state environmental protection agency for recommended methods or thresholds.

Step 2 Guidance: Characterize WHPA Hydrogeology

The Approach assumes that hydrogeologic features of the WHPA are relatively homogeneous and that the WHPA is inside the zone of contribution to the well (the area surrounding the well that supplies groundwater to the well). If actual conditions vary significantly from these assumptions, then you cannot use this manual to rank and screen potential contamination sources (for more details on this, see "What Does the Priority Setting Approach Assume" in Chapter 1).

- Photocopy one Wellhead Datasheet (Chapter 3) for each WHPA for which you will apply this Priority Setting Approach.

- Characterize the hydrogeology of the WHPA by completing the Wellhead Datasheet. You will only need to complete this datasheet once for each WHPA. You will use the data from the Wellhead Datasheet to complete the Transport Worksheet in Task IV (this datasheet is sometimes used in Task III as well).

- For the Planning Period (parameter WD1 on the Wellhead Datasheet), enter the number of years, from now into the future, over which you are concerned with the possibility of contamination of the wellhead. You may select a short-term planning period (e.g., 10 years) or a long-term planning period (e.g., 100 years). The Planning Period should be no less than the expected life of the wellfield in which the well is located. The Planning Period affects the calculation of the Likelihood of Reaching the Well (L_2, see Transport Worksheet, Task IV). Other things being equal, the longer the planning period, the higher the likelihood that contaminants released at the source will reach the well within the Planning Period considered.

- If the WHPA is located in a confined aquifer, then you will measure the depth to the aquifer from the source to the top of the confined aquifer, and not to the potentiometric surface. (For more details on this, see Technical Appendix A, "Hydrogeologic Setting.")

- You can determine the unsaturated zone Hydraulic Conductivity Score (WD5) in either of two ways. If you know the hydraulic conductivity of the unsaturated zone, then refer to Table W.2. If you do not know the hydraulic conductivity, then use Table W.3 to determine as a function of the type of material in the unsaturated zone. If you use Table W.3, do not choose Clay or Karst unless these materials account for at least 70 percent of the entire unsaturated zone. If clay or karst do not account for at least 70 percent of the material in the unsaturated zone, then choose the most appropriate material type from the following three categories: Clayey-Silt or Silt, Silty-Sand or Sand, or Sandy-Gravel or Gravel. Select the category that represents the most prevalent mix of materials throughout the unsaturated zone. For example, loam soils, a prevalent soil class, typically contain approximately 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand (see reference 3 in the bibliography). Therefore, if your unsaturated zone consists of loam soils, then the material type is either Clayey-Silt or Silt, or Silty-Sand or Sand. The material type will be Clayey-Silt or Silt if clay and silt make up more than 50 percent of the entire unsaturated zone. Conversely, the unsaturated zone material type will be Silty-Sand or Sand if it consists primarily (i.e., more than 50 percent) of silt and sand.

- One very good source of information on the type of material in the unsaturated zone is a soil survey map, which is available from your local Soil Conservation Service office. These maps diagram the various soil types that exist in a particular county and can be used to project the type of materials that exist in the unsaturated zone.

  Another source of information is well drillers' logs. A driller's log is prepared by a well drilling crew and describes the geologic material encountered while digging the well. However, the information in a driller's log is often unreliable and should be used only to refine data from soil survey maps.

Task II: Identify and Characterize Potential Sources of Well Contamination

Steps	Name and Location of Data Entry Sheets
3. Identify and locate all sources	
4. Identify and list all sources by source category and name	Block I of the Master Scoresheet (Chap. 3)
5. Characterize potential contaminants	Source Datasheets (Chap. 4)

Step 3 Guidance: Identify and Locate All Sources

- Identify the potential sources of ground-water contamination (see Exhibit 5) that are within the boundaries of the WHPA. You may also include sources located beyond the limits of your WHPA if you have any reason to believe that contaminants released from those sources could reach the well. For more assistance on how to identify sources of potential contamination, see: U.S. Environmental Protection Agency, Office of Ground Water and Drinking Water, *A Guide for Conducting Contamination Source Inventories for Public Drinking Water Supply Protection Programs*, Washington, D.C., 1991.

- When identifying sources, keep in mind that one facility may have many different sources. For example, a gasoline/service station may have an underground storage tank and a shallow injection well (e.g., an automobile service station disposal well). In such cases, you need to identify and analyze each different source separately. You may, however, want to group similar sources and analyze them as one source, as discussed next.

- To help you visualize the location of potential sources of contamination relative to the well, it is helpful to locate these sources on a map.

Exhibit 5
Sources and Source Categories

Sources (in alphabetical order)	Source Categories
Aboveground storage tanks: hazardous and non-hazardous waste treatment hazardous and non-hazardous waste storage hazardous and non-hazardous material storage	Tanks
Animal feedlots	Surface Impoundments
Containers: hazardous and non-hazardous waste storage hazardous and non-hazardous material storage	Container Storage and Material Transfer
Deep injection wells: wastewater disposal wells oil and gas activity disposal wells mineral extraction disposal wells	Injection Wells: Deep Wells (Classes I, II, and III)
De-icing salts storage piles	Storage Piles *
Fertilizer applications	Agrichemical Application
Graveyards	NA
Ground water/surface water cross contamination	NA
Irrigation practices (return flow)	NA
Land application: wastewater application (spray irrigation) wastewater byproduct (sludge) application petroleum refining waste application hazardous and non-hazardous waste application	Land Treatment
Landfills: industrial hazardous and non-hazardous landfill municipal sanitary landfill	Landfills
Material transfer operations: hazardous and non-hazardous waste transfers hazardous and non-hazardous material transfers	Container Storage and Material Transfer
Materials stockpiles: hazardous and non-hazardous material	Container Storage and Material Transfer
Mining and mine drainage	NA
Natural leaching	NA

(continued on next page)

NA = The Priority Setting Approach is not designed to rank this source
* = Use of this Approach's Source Category for this source is only an approximation

Exhibit 5 (continued)
Sources and Source Categories

Sources (in alphabetical order)	Source Categories
Open dumps	Landfills *
Pesticide applications	Agrichemical Application
Pipelines: hazardous and non-hazardous waste (sewers) hazardous and non-hazardous material	Pipelines
Radioactive disposal sites	NA
Salt-water intrusion	NA
Septic tanks: houses apartments small businesses	Septic Tank Systems
Shallow injection wells: agricultural drainage wells automobile service station disposal wells industrial process water disposal wells	Injection Wells: Shallow Wells (Class V)
Storm water drainage wells	Surface Impoundments
Surface impoundments: hazardous and non-hazardous waste cesspools, ponds, lagoons, and other impoundments	Surface Impoundments
Transportation of materials: hazardous and non-hazardous waste hazardous and non-hazardous material	Material Transport
Underground storage tanks: hazardous and non-hazardous waste treatment hazardous and non-hazardous waste storage hazardous and non-hazardous material storage	Tanks
Urban runoff	Surface Impoundments *
Waste tailings: heap leaching piles non-heap leaching piles	Storage Piles
Waste piles: hazardous and non-hazardous waste piles	Storage Piles

NA = The Priority Setting Approach is not designed to rank this source
* = Use of this Approach's Source Category for this source is only an approximation
Source: Based on data provided by the Office of Technology Assessment, U.S. Congress

Step 4 Guidance: List Sources by Category and Name

- For each WHPA, make as many copies of the Master Scoresheet (Chapter 3) as you need so that you can list all your sources at all your WHPAs. The instructions below will help you determine how many copies to make.

- In some cases, it is more appropriate to apply the Priority Setting Approach to a group of sources within the same source category than to consider each source individually (i.e., rather than complete one datasheet/worksheet pair for each individual source separately). *The source categories that allow you to group sources* are Deep Injection Wells, Shallow Injection Wells, Septic Tank Systems, and Tanks. You may group individual sources that fall under these source categories if the individual sources meet all of the following three conditions:

  (1) The individual sources must share similar design parameters (e.g., shallow injection wells of comparable type and age).

  (2) The individual sources must all be located within one of the following distance ranges: less than one-eighth mile, one-eighth to one-quarter mile, one-quarter to one-half mile, one-half to one mile, one to three miles, or three to five miles. For example, if several product and waste storage tanks are all located between one-quarter and one-half mile, then you may be able to cluster these tanks.

  (3) The individual sources must dispose of the same or similar contaminants (e.g., two Class I deep injection wells that are used to dispose of both chromium and sulfuric acid wastes).

- Use Exhibit 5 to find the source category that applies to each of your sources. For example, Exhibit 5 directs you to use the Agrichemical Application source category if your source is fertilizer applications. Note that you will not be able to rank and screen certain types of sources using this Approach. Exhibit 5 denotes these sources with an "NA" in the second column. An asterisk (*) in Exhibit 5 denotes sources for which the source category recommended is only an approximation. For stormwater drainage wells, for example, the Surface Impoundments source category is only an approximation because this source category was specifically designed for traditional surface impoundments such as lagoons and ponds. Although storm water drainage wells technically are Class V injection wells, the Surface Impoundments source category comes the closest to modeling the risks posed by this type of Class V well.

- If your sources include abandoned oil and gas wells, you may want to consider using the following publication for a more detailed assessment of these sources: U.S. Environmental Protection Agency, Underground Injection Control Branch, Office of Water and Drinking Water, *Revised Risk Assessment for Abandoned Oil and Gas Wells*, forthcoming, 1992.

- Write the source category and name of each source on Block I of the Master Scoresheet in Chapter 3.

  The Master Scoresheet provides space for you to evaluate risks for up to three contaminants or contaminant mixtures per source. If you think you will need to evaluate more contaminants or contaminant mixtures for a given source, skip as many groups of three rows as you will need in the Master Scoresheet now.

- Number your sources in sequence in the first column of the Master Scoresheet. Use this number to identify each source as you proceed.

Step 5 Guidance: Characterize Potential Contaminants

- In Chapter 4, you will find one blank Source Datasheet/Worksheet pair for each source category. Photocopy the appropriate pair of sheets for each source or group of sources within your WHPA(s). For example, if you have two hazardous landfills and one sanitary landfill in your WHPA, you will need to make three copies of the Landfills Datasheet and three copies of the Landfills Worksheet.

- At the top of each Source Datasheet, record the Source Number, Source Name, and Source Location. Use the same Source Number and Source Name as in Block I of the Master Scoresheet.

- For each source listed in Block I of the Master Scoresheet, you will need to specify the following on each Source Datasheet:

  -- source age and design parameters
  -- distance from the well
  -- contaminants or contaminant mixtures present.

- Each Source Datasheet has a question that asks you: "Does the source discharge directly to a conduit system (e.g., pipes or utility chase) that could transport contaminants directly to the well?" The concern here is that a conduit (e.g., a gravel-filled trench that carries a water main) could convey contaminants from a source to the well. To convey contaminants, the conduit must run between a potential source of contamination and the well, and thus provide a shortcut for contaminants around the unsaturated and saturated zones. If the source does discharge directly to a conduit system that could transport contaminants, then the Transport Worksheet (Task IV) will guide you to set the Likelihood that contaminants will reach the well to 0 (i.e., a 100 percent chance of reaching the well).

- For some parameters, the datasheets provide default values. While site-specific data are always preferred, you may use the default values if specific information is not readily available. For more details on the use of defaults, please refer to the "Using Defaults" discussion earlier in this chapter.

- Choose up to three contaminants or contaminant mixtures associated with the source and list them in the Contaminant Data Table of the Source Datasheet. If you choose more than three contaminants, you can write the additional contaminant names and corresponding scores in the available space on the source datasheets and worksheets. You will need to use Contaminant Forms S.1 and/or S.2 in Chapter 3 to complete the Contaminant Data Table.

  -- **If you know the contaminants present at the source and the concentration of each contaminant**, then

  (1) use Form S.1 to obtain the persistence, mobility, and toxicity of those contaminants, and

  (2) convert the concentration value (in ppm or mg/l) into a concentration score using the Contaminant Concentration Scoring Graph that follows Form S.1. For Agrichemical Application sources, use the application rate in kg/hectare/yr instead of concentration.

  -- **If you do not know the contaminants present at the source or their concentrations**, then use Form S.2 to identify characteristic contaminants and to obtain default scores for persistence, mobility, toxicity, and concentration by source category and subcategory.

  For more information on how to use Forms S.1, S.2, and the Contaminant Concentration Scoring Graph, see the introduction to Contaminant Forms S.1 and S.2 in Chapter 3.

- If you group sources, you will complete one datasheet/worksheet pair for each group of sources. For a block of homes that use septic tank systems, for example, you will begin by completing one datasheet. To do this, you will need to determine the average age of the group of septic tank systems (step SD1), estimate the aggregate amount of sewage throughput of all the septic tank systems (step SD2), and determine the distance range for all the septic tank systems from the well (step SD3). Using these data from the datasheet, you can then complete one worksheet for this group of septic tank systems. For an illustration of how to group sources, refer to the hypothetical example in the next section.

- Make a note on the contaminant data table of whether your source contains <u>potential</u> dense non-aqueous phase liquids (DNAPLs) or <u>potential</u> light non-aqueous phase liquids (LNAPLs), as identified in Form S.1 under the column heading "Type." DNAPLs, also known as sinkers, are contaminants with densities greater than water and are relatively insoluble in water. LNAPLs, also known as floaters, are contaminants with densities less than water and are relatively insoluble in water. <u>Potential</u> DNAPLs and LNAPLs will act as true DNAPLs or LNAPLs if they are released in great enough quantities. The guidance under Task III, Step 6 will help you determine whether a <u>potential</u> DNAPL or LNAPL will act as a true DNAPL or LNAPL. For a more detailed discussion of the special risks posed by DNAPLs and LNAPLs, see Technical Appendix A.

A NOTE ON NEGATIVE SCORES

Human health risk assessments are calculated by multiplying variable factors (such as toxicity or potency of a substance and the frequency and duration of exposure) to derive a numerical risk assessment based on the probability of an expected outcome, such as one in one million cancer deaths from prolonged exposure to asbestos, etc.

For this Approach, the natural numbers in the scoring system have been converted to decimal logarithms for use in the equation: Risk = Likelihood + Severity. Thus, when users are adding the variables in this Approach, the variables are in effect being multiplied, as in the calculation of human health risk assessments.

As you complete the Source Datasheets and all other sheets of this manual, you will find that many scores are negative numbers. The reason these scores are negative is because the scoring system here is based on the decimal logarithmic conversion of natural units. For example, if there is a 50 percent chance contaminants will be released from a given source, then the Likelihood of Release score for that contaminant at that source is -0.3 ($\log_{10}(0.5)$). Be careful to precede all numbers with the correct sign (+ or -) as you copy scores from one sheet to another. Also keep in mind the meaning of the sign as you compare scores; that is, a score of (-2) is greater than a score of (-3).

Task III: Perform Source Calculations

Steps	Name and Location of Data Entry Sheets
6. Using data from the Wellhead and Source Datasheets, assess contaminants released from the source	Source Worksheet (Chap. 4)
7. Transfer scores L_1, Q, and T to the Master Scoresheet	Block II of the Master Scoresheet (Chap. 3)

Step 6 Guidance: Assess Contaminants Released from the Source

- In Chapter 4, you will find one blank Source Datasheet/Worksheet pair for each source category. If you have not done so already, photocopy as many copies of the appropriate

Source Worksheets as there are corresponding sources or groups of sources within your WHPA(s).

- For each source, work through all of the steps in the corresponding Source Worksheet found in Chapter 4. You will be estimating two source-related elements of risk:

  -- L_1 Likelihood of Release at the Source
  -- Q Quantity Released at the Source

  In order to complete the steps in the Source Worksheet, you will need to look up data in the corresponding Source Datasheet and in some cases, the Wellhead Datasheet (Chapter 3).

- Each source will have only one L_1 score because L_1 does not depend on the contaminant or contaminant mixture analyzed. However, there will be one Q score for each contaminant or contaminant mixture at the source.

- If the Quantity score for a potential DNAPL or LNAPL (identified under the guidance for Task II, Step 5 and on Contaminant Form S.1) is greater than or equal to 3, then the contaminant is a true DNAPL or LNAPL. In this case, this Approach may overestimate or underestimate the risks posed by that contaminant. For a more detailed discussion of DNAPLs and LNAPLs, see Technical Appendix A.

Step 7 Guidance: Transfer Scores to Master Scoresheet

- Copy the L_1 and Q scores from the Source Worksheet, and the Toxicity scores (T) from the corresponding Source Datasheet, onto Block II of the Master Scoresheet (Chapter 3).

Task IV: Perform Transport Calculations

Steps	Name and Location of Data Entry Sheets
8. Using data from the Wellhead and Source Datasheets, assess contaminant transport	Transport Worksheet (Chap. 4)
9. Transfer the L_2 and A scores to the Master Scoresheet	Block II of the Master Scoresheet (Chap. 3)

Step 8 Guidance: Assess Contaminant Transport

- Photocopy one Transport Worksheet for each source within your WHPA(s).
- You will estimate two transport-related elements of risk for each contaminant or contaminant mixture:

  -- L_2 Likelihood of Reaching the Well
  -- A Attenuation Due to Transport.

  You will need to use data from the Wellhead Datasheet (Chapter 3) and the corresponding Source Datasheet (Chapter 4) to complete this step.

Step 9 Guidance: Transfer Scores to Master Scoresheet

- Copy the L_2 and A scores for each contaminant or contaminant mixture to Block II of the Master Scoresheet (Chapter 3).

Task V: Estimate Risks and Rank Sources

Steps	Name and Location of Data Entry Sheets
10. Determine contaminant-specific L, S, and Risk Scores	Block III of Master Scoresheet (Chap. 3)
11. Determine source-specific Risk, Rank, and Risk Level	Block III of Master Scoresheet (Chap. 3)
12. Plot each source on the Risk Matrix	Risk Matrix (Chap. 3)

Step 10 Guidance: Determine Contaminant-Specific Risk Scores

- Working directly from the Master Scoresheet, determine the Likelihood of Well Contamination (L) and Severity of Well Contamination (S) scores for each contaminant or contaminant mixture at each source as follows:

$$L = L_1 + L_2$$

$$S = Q + A + T$$

- Compute the Risk Score for each contaminant or contaminant mixture at each source as the sum of the Likelihood of Well Contamination (L) and the Severity of Well Contamination (S):

$$\text{Risk score} = L + S$$

  -- For example, if a contaminant or contaminant mixture has a Likelihood of Well Contamination (L) of -1.5 and a Severity of Well Contamination (S) of 0.5, then this contaminant or contaminant mixture has a Risk score of -1 (i.e., -1.5 + 0.5).

- The Priority Setting Approach may overestimate or underestimate the risks posed by true DNAPLs or LNAPLs (see Task III, Step 6 for guidance on identifying DNAPLs and LNAPLs). Because of the complexity of the transport phenomena involved, this Approach does not provide guidance on whether the risk scores will be overestimated or underestimated in the case of DNAPLs or LNAPLs. Therefore, this Approach may not be applied for potential DNAPLs or LNAPLs with a Quantity score of 3 or more. For a more detailed discussion of DNAPLs and LNAPLs, see Technical Appendix A.

- Note that the L+S formula assumes that you place equal weights on the Likelihood and Severity of Well Contamination posed by a given contaminant or contaminant mixture. If you value one of these risk factors more than the other, you may want to determine the Risk score differently (see the discussion on "Using the Risk Matrix" at the end of this task). The Risk score always increases as either Likelihood or Severity of Well Contamination increases, as long as the other score does not decrease.

- This Approach equates a 10^{-5} lifetime cancer risk to a lifetime exposure to the reference dose (RfD) for non-carcinogens. You can alter this assumption to reflect different policies. For more discussion on how to do this, see Technical Appendix A.

Step 11 Guidance: Determine Source-Specific Overall Risk Scores

- At this point, you may choose to track carcinogenic risks and non-carcinogenic risks either together or separately. You can determine whether a contaminant is a carcinogen or a non-carcinogen from Contaminant Forms S.1 and S.2 (Chapter 3). If you distinguish between these risks, you will end up with two separate source rankings: one ranking for carcinogenic risks and one ranking for non-carcinogenic risks. When deciding whether to distinguish between carcinogenic and non-carcinogenic risks, it may be helpful to consider the end use of your results. For an explanation of the difference between these two types of risk and the assumptions built into this Approach for comparing them, refer to Technical Appendix A.

If you choose not to distinguish between carcinogenic and non-carcinogenic risks:

- Determine the Overall Risk score for each source by selecting the maximum contaminant-specific Risk score obtained in Step 10.

-- For example, if a given source has three contaminants or contaminant mixtures with Risk scores equal to -200, -2.1, and -0.5, then this source has an Overall Risk score equal to -0.5 (i.e., the maximum of -200, -2.1, and -0.5).

- Write the Overall Risk for each source in the corresponding column of Block III of the Master Scoresheet. Note that the higher the Overall Risk score, the higher the risk to the well posed by a given source.

- Rank your sources on the basis of the Overall Risk scores, giving the source with the highest Overall Risk score a Rank of 1.

  -- For example, if your WHPA has two sources A and B with Overall Risk scores equal to -2.5 and -0.7, respectively, then source B poses a greater risk to the well than source A. Therefore, source B would be assigned a Rank of 1 and source A a Rank of 2.

- Write the Rank for each source in the Rank column of the Master Scoresheet (Block III).

- Based on the Overall Risk Scores, determine the Risk Level (i.e., Low, Medium, or High) for each source using the following table:

Overall Risk	Risk Level
Less than -4	Low
Between -4 and 0, inclusive	Medium
Greater than 0	High

  -- For example, if a given source has an Overall Risk score equal to -6, then this source poses a Low risk of well contamination. Alternatively, a source with an Overall Risk score of 0.5 is a High risk source.

- Write the Risk Level for each source in the last column of Block III of the Master Scoresheet.

If you choose to track carcinogenic and non-carcinogenic risks separately:

- Determine a Carcinogenic Overall Risk score and a Non-Carcinogenic Overall Risk score for each source. The Carcinogenic Overall Risk score is the maximum of the contaminant-specific Risk scores for all carcinogens at the source. Likewise, the Non-

Carcinogenic Overall Risk score is the maximum of all non-carcinogenic contaminant-specific Risk scores.

- You will generate two rankings of all sources: one ranking based on the Carcinogenic Risk scores and one ranking based on the Non-Carcinogenic Risk scores. You will also determine two Risk Levels for each source: one Carcinogenic Risk Level and one Non-Carcinogenic Risk Level.

Step 12 Guidance: Plot Each Source on the Risk Matrix

- Photocopy one Risk Matrix (Chapter 3) for each WHPA for which you will apply the Priority Setting Approach.

- Plot each source on the Risk Matrix based on the Likelihood of Well Contamination (L) and Severity of Well Contamination (S) scores for the contaminant or contaminant mixture with the highest Risk score. The Risk Matrix allows you to visualize the relationship between these two components of risk by the most "problematic" contaminant or contaminant mixture present at the source.

- The Likelihood of Well Contamination (L) is on the vertical axis and varies from -7 to 0. Note that a Likelihood (L) score of 0 corresponds to the log to the base 10 of a probability of well contamination of 1, i.e., a 100 percent likelihood of contamination. If the L score is less than -7 (e.g., -8), then plot that source in the * "row" of the Risk Matrix, meaning that there is a negligible likelihood of well contamination.

- The Severity of Well Contamination (S) is on the horizontal axis and varies from -5 to +5. For carcinogens, a Severity (S) score of 0 corresponds very roughly to an individual lifetime risk of 10^{-5}. For non-carcinogens, a Severity score of 0 corresponds very roughly to an exposure dose equal to the Reference Dose. For a more detailed discussion of these scores, refer to Technical Appendix A. If the S score is less than -5 (e.g., -6), then plot that source in the * "column" of the Risk Matrix, meaning the severity of contamination is negligible.

Using the Risk Matrix: An Example

To illustrate the final risk calculations and the use of the Risk Matrix, assume a WHPA with only two sources: A and B. Source A has one contaminant (nitrates), while source B has two contaminants (chloroform and 1,1,1-trichloroethane). A complete application of this Priority Setting Approach for these two hypothetical sources is provided in the next section.

Assume the following risk scores:

Source	Contaminant/Mixture	L	S	Risk	Overall Risk	Rank	Risk Level
A	Nitrates	0	-1.8	-1.8	-1.8	1	Medium
B	Chloroform	-2.3	-0.3	-2.6	-2.4	2	Medium
	1,1,1-trichloroethane	-2.4	0	-2.4			

As explained under the guidance for Step 10, the Risk score for each contaminant or contaminant mixture is the sum of L and S; hence the contaminant-specific Risk scores in the table above. Following the Step 11 Guidance, the Overall Risk score for each source is the *maximum* of all contaminant-specific Risk scores (if one does not distinguish between carcinogens and non-carcinogens). Thus, source A has an Overall Risk score of -1.8 and source B an Overall Risk score of -2.4. Based on the Overall Risk scores of sources A and B, source A gets a Rank of 1 (i.e., it poses the highest relative risk of contaminating the well), while source B gets a Rank of 2 (-2.4 is less than -1.8). Both sources, however, pose a Medium Risk Level (both -1.8 and -2.4 are between -4 and 0).

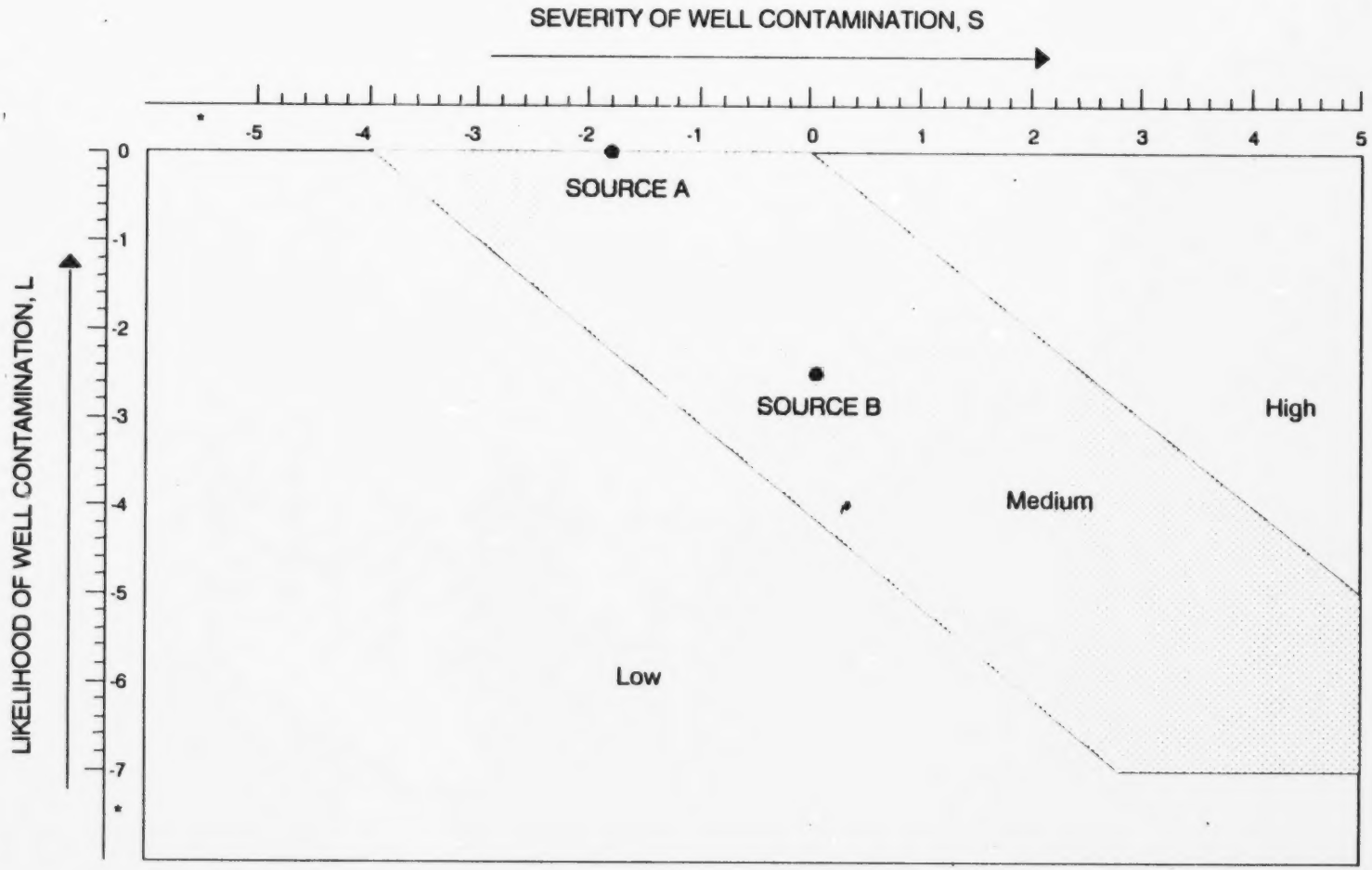
Now plot sources A and B on the Risk Matrix (Step 12). As illustrated in Exhibit 6, source B is plotted based on the L and S scores for 1,1,1-trichloroethane, the contaminant or contaminant mixture with the highest Risk score (-2.4 for 1,1,1-trichloroethane versus -2.6 for chloroform). The plot for source A uses the L and S values for nitrates, the only contaminant analyzed. Note the following:

(1) The Overall Risk score for source A (-1.8) is greater than the Overall Risk score for source B (-2.4) because you have given equal weight to the Likelihood and Severity of well contamination.

(2) Although source A has a greater Likelihood of contaminating the well than source B, source A has a smaller potential Severity of well contamination. Therefore, if you are more concerned with the Severity than the Likelihood of well contamination, then you may give greater weight to Severity and rank source B as a greater risk than source A.

Exhibit 6

Risk Matrix - Hypothetical Example



For Modified Use of this Approach

- **If you do weigh Likelihood and Severity unequally**, you may want to ignore the L+S formula in the Step 10 guidance and instead determine the contaminant-specific Risk scores by **plotting each contaminant or contaminant mixture at each source** on the Risk Matrix. This will provide a more detailed picture of the Likelihood and Severity components of the risk from the source, rather than a picture based on a single "worst-case" contaminant or contaminant mixture. There is no "formula" to aggregate the separate risk scores for each contaminant if you choose to weigh Likelihood and Severity unequally.

- You may also wish to draw your own shaded areas on the Risk Matrix for different risk levels that reflect your own value judgments on the management of risks posed by different combinations of Likelihood and Severity (e.g., by enlarging the high-risk area and decreasing the low-risk area).

- The type of situation where you might **most** want to consider giving a greater weight to Severity is in the case of a source that has a very high Severity score, but a low Likelihood score. For example, a massive tank rupture or a highly toxic release very close to the water supply would pose a high Severity of contaminating a well, but the Likelihood of this happening may be low. This is in contrast to events that are very likely to occur, but have a low Severity associated with them, such as low-level nitrate contamination from low-density septic systems.

- The expenditure of resources in preventing or eliminating medium to low-Likelihood events is usually driven by the accompanying degree of Severity associated with the potential occurrence. For example, given the high Severity of a toxic release from an underground storage tank, a community may well decide to spend the majority of their resources attempting to prevent the occurrence, thereby reflecting an actual increase in the degree of Severity in terms of consequences of the event.

  On the other hand, if the perceived Likelihood of occurrence is so low that the risk manager feels comfortable in assigning less weight to Severity, it is likely that the community will expend proportionately less in resources in attempting to prevent the occurrence. This decision then reflects a reverse of the preceding one, and assigns a correspondingly lower degree of Severity in terms of the consequences of the event.

  The series of value judgments that are unique for each potential occurrence require that the risk manager balance probability with consequences. While these value judgments and risk management decisions involve issues that go beyond the scope of this User's Guide, the advantage in using the Priority Setting Approach lies in the ability to rank the probability of occurrence **and** the consequences of the event simultaneously. Using this information, the risk manager can then formulate the prioritize decisions for each situation based on relative importance within that management setting.

HYPOTHETICAL EXAMPLE OF USING THE PRIORITY SETTING APPROACH

This section presents a hypothetical example of how to use this Approach. It begins with a brief scenario to set the stage for the example, and then presents a hypothetical application of this Approach for each of the Approach's tasks and steps. The completed sheets for each task are presented at the end of this section.

The Scenario

Ms. Amy Prudent, manager for the city of Anypolis, Tennessee WHPA, has just identified a number of potential sources of contamination within the city's WHPA. To determine her source management priorities, she decided to use this manual to help rank and screen these sources. This example focuses on how Ms. Prudent applies this Priority Setting Approach to two sources: a group of septic systems and an underground storage tank.

Exhibit 7 presents the flow diagram for the tasks Ms. Prudent performs. Ms. Prudent will complete one Wellhead Datasheet, the Source Datasheet and Worksheet for Septic Tank Systems, the Source Datasheet and Worksheet for Tanks, and two Transport Worksheets (one for each source). As she completes these datasheets and worksheets, she transfers data to the first two blocks in Master Scoresheet. Finally, she will complete the third and last block of the Master Scoresheet and plot the two sources on the Risk Matrix.

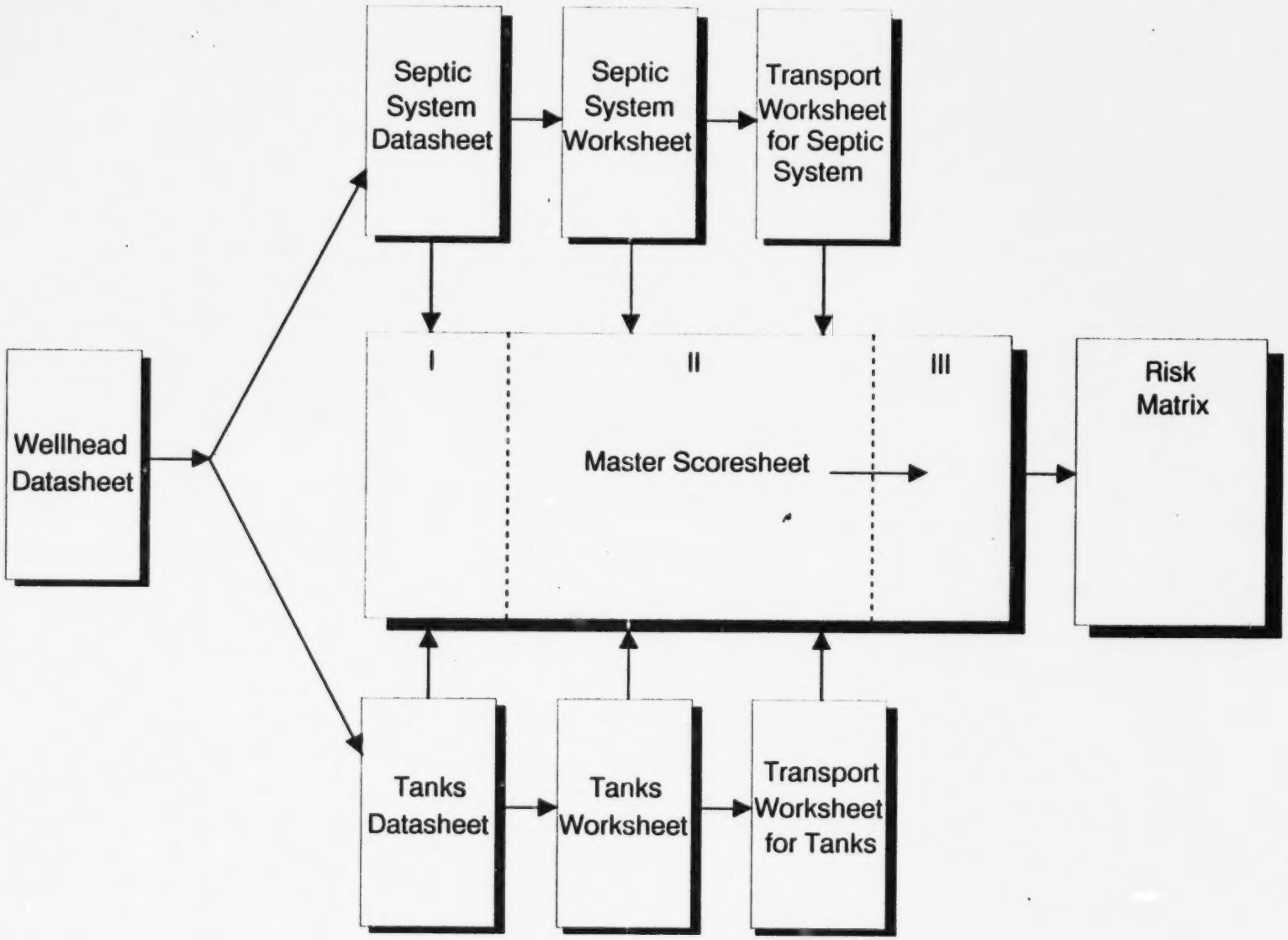
Task I: Characterize Your WHPA

Steps	Name and Location of Data Entry Sheets
1. Map WHPA boundaries	
2. Characterize WHPA hydrogeology	Wellhead Datasheet (Chap. 3)

Step 1: Map WHPA Boundaries

Ms. Prudent identifies the boundaries of the WHPA with assistance from the following guidance document: U.S. Environmental Protection Agency, Office of Ground-Water Protection, *Guidelines for Delineation of Wellhead Protection Areas*, Washington, D.C., 1987.

Exhibit 7
Flow Diagram for the Hypothetical Example



Step 2: Characterize WHPA Hydrogeology

Using local soils maps, available well logs, and other data, Ms. Prudent determines that the WHPA has the following hydrogeologic characteristics and enters them on the Wellhead Datasheet:

- the depth to the aquifer is 35 feet
- the aquifer thickness is 10 feet
- The net infiltration is 20 inches
- the unsaturated zone hydraulic conductivity is between 10^{-5} and 10^{-4} centimeters per second
- the saturated zone material is sand
- the pumping rate is approximately 48 million gallons per day.

In addition, Ms. Prudent is concerned about potential contamination within the wellfield for several generations into the future. Therefore, she enters 150 years for the Planning Period in parameter WD1 on the Wellhead Datasheet. Based on all of this information, Ms. Prudent completes the Wellhead Datasheet as presented at the end of this section (see Completed Sheets from Task I: Wellhead Datasheet).

Task II: Identify and Characterize Potential Sources of Well Contamination

Steps	Name and Location of Data Entry Sheets
3. Identify and locate all sources	
4. Identify and list all sources by source category and name	Block I of the Master Scoresheet (Chap. 3)
5. Characterize potential contaminants	Source Datasheet (Chap. 4)

Step 3: Identify and Locate All Sources

After conducting a comprehensive survey of current land uses within the WHPA, Ms. Prudent identifies the following activities as potential sources of contamination:

- 165 houses, 70 apartment units, and 25 small businesses that use septic systems
- one underground hazardous waste storage tank at Widgets-R-Us Inc.

Step 4: List Sources by Category and Name

Using Exhibit 5, Ms. Prudent identifies the Source Categories she will use to characterize the sources and completes Block I of the Master Scoresheet. For the septic systems and the hazardous waste underground storage tank, Ms. Prudent uses the Septic Tank Systems and Tanks source categories, respectively.

Because the septic systems are all located within the same distance range to the well, as defined by the Distance Scoring Form in the Septic Tank Systems Datasheet, Ms. Prudent groups these septic systems into a single source.

Step 5: Characterize Sources

Ms. Prudent completes the Septic Tank Systems Datasheet using the following data on the group of septic systems:

- The average age of the septic systems is approximately 30 years.
- The throughput is 40,191 thousand gallons per year.
- The houses, apartments, and small businesses are all between one-eighth and one-quarter of a mile from the wellhead.
- No underground conduit system extends between the septic tanks and the well.
- Ms. Prudent does not know what contaminants the septic systems release, so she uses Contaminant Form S.2 (Chapter 3) to complete the Contaminant Data Table in the datasheet. According to Form S.2, the contaminant associated with septic systems is nitrates. The form provides default values for toxicity, mobility and persistence for this contaminant.

At this point, Ms. Prudent turns to the Tanks Datasheet and begins completing it. Alternately, she could have proceeded to Task III to complete the Septic Tank Systems Worksheet. If she had chosen to proceed to Task III, she ultimately would have had to return

to Task II to complete the Tanks Datasheet. Ms. Prudent completes the Tank Datasheet using the following data:

- The tank has a capacity of 25,000 gallons.
- It is a below-ground, fiber-reinforced plastic tank.
- The tank is one-year old.
- The tank is approximately 2,000 feet from the wellhead
- No underground conduit system extends between the tank and the well.
- After talking to the manager of the Widgets-R-Us, Ms. Prudent learns that the tank contains the contaminants chloroform, at a concentration of 10,000 mg/l, and 1,1,1-trichloroethane, at a concentration of 35,000 mg/l.

Ms. Prudent uses Contaminant Form S.1 (Chapter 3) to enter the Toxicity, Mobility, and Persistence scores for chloroform and 1,1,1-trichloroethane onto the Contaminant Data Table in the datasheet. To determine the Concentration score for these contaminants, she uses the Contaminant Concentration Scoring Graph provided at the end of Contaminant Form S.1 (Chapter 3). At concentrations of 10,000 mg/l and 35,000 mg/l, the Concentration scores for chloroform and 1,1,1-trichloroethane are 1.0 and 1.5, respectively.

Task III: Perform Source Calculations

Steps	Name and Location of Data Entry Sheets
6. Using data from the Wellhead and Source Datasheets, assess contaminant releases from the source	Source Worksheets (Chap. 4)
7. Transfer L_1, Q, and T scores to the Master Scoresheet	Block II of the Master Scoresheet (Chap. 3)

Step 6: Assess Contaminant Releases from the Source

Ms. Prudent completes the Septic Tank Systems Worksheet using data from the Septic Tanks Systems Datasheet. Note that the Likelihood of Release (L_1) score is equal to zero (which is equivalent to a likelihood of 100 percent) because septic systems are designed to release to the unsaturated and saturated zones. Ms. Prudent then completes the Tanks Worksheet using data from the Tanks Datasheet.

Step 7: Transfer Scores to the Master Scoresheet

Ms. Prudent transfers the following scores onto Block II of the Master Scoresheet: the Toxicity (T) score from step SD5 in the Septic Tank Systems Datasheet and the Likelihood of Release (L_1) and Quantity (Q) scores from steps 1 and 3, respectively, in the Septic Tank Systems Worksheet. Likewise, she transfers the T, L_1, and Q scores from the Tanks Datasheet and Worksheet onto Block II of the Master Scoresheet for each contaminant.

Task IV: Perform Transport Calculations

Steps	Name and Location of Data Entry Sheets
8. Using data from the Wellhead and Source Datasheets, assess contaminant transport	Transport Worksheets (Chap. 4)
9. Transfer the L_2 and A scores to the Master Scoresheet	Block II of the Master Scoresheet (Chap. 3)

Step 8: Assess Contaminant Transport

Ms. Prudent completes the Transport Worksheet for the septic systems using data from the Wellhead Datasheet and the Septic Tank Systems Datasheet. Likewise, she completes a Transport Worksheet for the underground storage tank using data from the Wellhead Datasheet and the Tanks Datasheet.

Step 9: Transfer Scores to the Master Scoresheet

Ms. Prudent transfers the following scores onto Block II of the Master Scoresheet: the Likelihood of Reaching the Well (L_2) score and the Attenuation Due to Transport (A) score from steps 5 and 8, respectively, in the Transport Worksheet for the septic systems. Likewise,

for each contaminant, she transfers the L_2 and A scores from the Transport Worksheet for the tank onto Block II of the Master Scoresheet.

Task V: Estimate Risks and Rank Sources

Steps	Name and Location of Data Entry Sheets
10. Determine contaminant-specific L, S, and Risk Scores	Block III of Master Scoresheet (Chap. 3)
11. Determine source-specific Risk, Rank, and Risk Level	Block III of Master Scoresheet (Chap. 3)
12. Plot each source on the Risk Matrix	Risk Matrix (Chap. 3)

Step 10: Determine Contaminant-Specific Risk Scores

Next, Ms. Prudent determines the Likelihood of Well Contamination (L), the Severity of Well Contamination (S), and the Risk score for the septic systems using the following formulas:

$$L = L_1 + L_2$$

$$S = Q + A + T$$

$$\text{Risk score} = L + S.$$

She enters the L, S, and Risk scores for the septic systems onto Block III of the Master Scoresheet. Likewise, she enters the L, S, and Risk scores for each contaminant present at the underground storage tank onto Block III of the Master Scoresheet. For the purposes of this example, Ms. Prudent recognizes and accepts the equal weight that this Approach places on L and S based on the formula for determining the Risk score.

Step 11: Determine Source-Specific Overall Risk Scores

Ms. Prudent determines the Overall Risk score for each source as the highest contaminant-specific Risk score present at each source. Because nitrate is the only contaminant of concern for the septic systems, the Overall Risk score for this source is the Risk score for nitrates, or -1.8. Ms. Prudent chooses not to distinguish between the carcinogenic and non-carcinogenic risks presented by the underground storage tank. Therefore, she determines the Overall Risk

for the tank as the maximum between the Risk score for chloroform (i.e., -2.6) and the Risk score for 1,1,1-trichloroethane (i.e., -2.4). Because -2.4 is greater than -2.6, Ms. Prudent determines that the Overall Risk score for the underground storage tank is -2.4. She enters these scores in the "Overall Risk" column of Block III of the Master Scoresheet.

Ms. Prudent ranks the sources on the basis of the Overall Risk scores, where the source with the higher Overall Risk score is assigned a higher rank. Ms. Prudent ranks the septic systems first (i.e., it poses a relatively greater risk of contaminating the well) and she ranks the underground storage tank second because the Overall Risk score for the septic systems (-1.8) is higher than the Overall Risk score for the underground storage tank (-2.4). She enters these scores in the "Rank" column of the Master Scoresheet.

Ms. Prudent then assigns the septic systems a Risk Level based its Overall Risk score. Likewise, she assigns the underground storage tank a Risk Level based on its Overall Risk score. The Risk Level for both sources is Medium. She then enters these scores in the "Risk Level" column of the Master Scoresheet.

Step 12: Plot Each Source on Risk Matrix

Finally, Ms. Prudent plots the septic system on Risk Matrix based on its L score (i.e., 0) and its S score (i.e., -1.8). For the underground storage tank, she plots the risk scores for the contaminant with the highest Risk score (i.e., 1,1,1-trichloroethane). Therefore, for the underground storage tank she plots its L score as -2.4 and its S score as 0. Ms. Prudent sees that she plotted both sources in the Medium risk range, which corresponds to each source's Risk Level.

(In this case, had Ms. Prudent chosen to differentiate between the carcinogenic and non-carcinogenic risks, it would not have changed the overall ranking of the sources or their position in the matrix. If the overall ranking had changed, Ms. Prudent would have had to incorporate this additional consideration into her decision making process.)

The interpretation of the risk matrix is largely up to the user. Please refer to the discussion on the risk matrix in this chapter for a more thorough discussion of the different ways to interpret the matrix.

COMPLETED SHEETS FROM TASK I:

WELLHEAD DATA SHEET

Step 2

Author: A. Prudent

WELLHEAD DATASHEET

Date: 6/17/91

PARAMETER	INSTRUCTIONS	SCORE
WD1 Planning Period	Enter the number of years over which you are concerned with the possibility of contamination of the well. Other things being equal, the longer the planning period, the higher the likelihood that contaminants released at the source will reach the well within the Planning Period considered.	150
WD2 Depth to Aquifer Score	Use **Table W.1** to convert the depth to the aquifer in the wellhead protection area (WHPA) into a Depth to Aquifer Score. For example, if the depth to the aquifer is between 50 feet and 150 feet, then the Depth to Aquifer Score is equal to 1.5. **Note:** If you have a confined aquifer, please refer to Setting 4 in Technical Appendix A under the heading "Aquifer Physical Properties."	1
WD3 Aquifer Thickness Score	Use **Table W.1** to convert the thickness of the aquifer in the WHPA into an Aquifer Thickness Score. For example, if the aquifer thickness is between 3.6 meters and 1.5 meters, then the Aquifer Thickness Score is equal to 1.0. Note that you are using the same table for determining the Depth to Aquifer Score and the Aquifer Thickness Score.	.3
WD4 Net Infiltration	Enter the annual net infiltration in inches for the WHPA. If this is not known, use the net infiltration map (**Figure W.1**) to determine the Net Infiltration given the geographic location of the WHPA. For example, if the WHPA is in New York State, then the Net Infiltration is equal to 20.	20

Table W.1

Depth to Aquifer or Aquifer Thickness	(m)	0-3.6	3.6-15	15-45	45-260
	(ft)	0-12	12-50	50-150	150-850
Depth to Aquifer Score or Aquifer Thickness Score		0.3	1.0	1.5	2.2

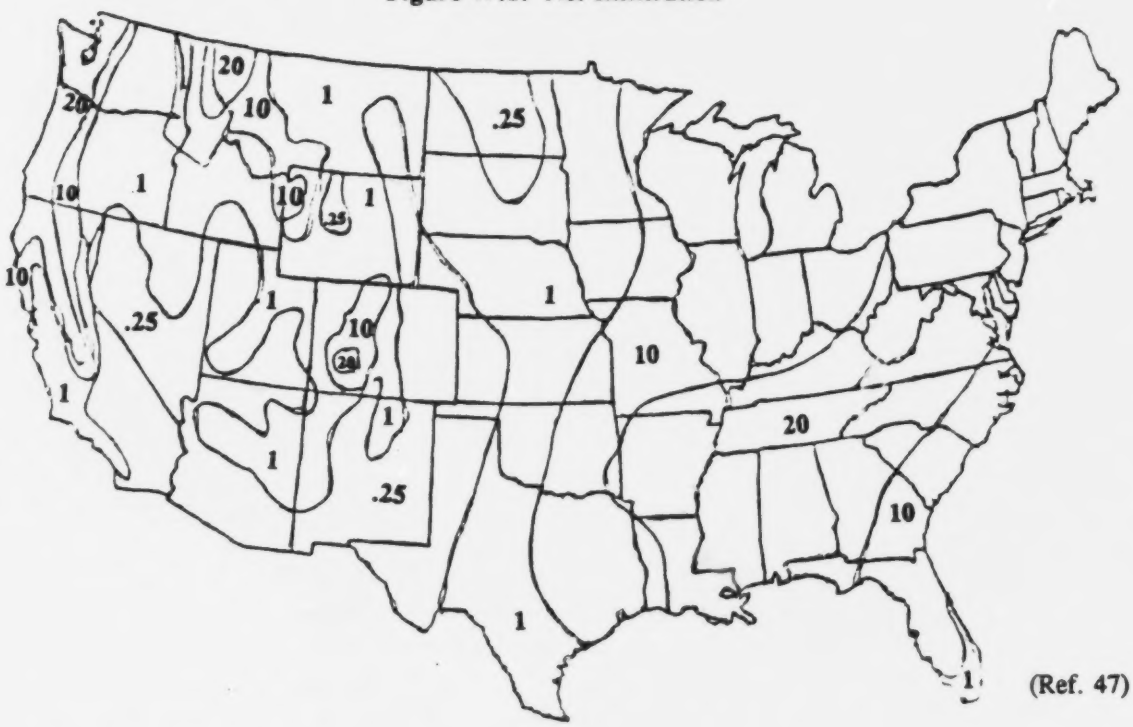
Table W.2

Hydraulic Conductivity (cm/s)	10^{-9} - 10^{-7}	10^{-7} - 10^{-5}	10^{-5} - 10^{-3}	10^{-3} - 10^{-1}	10^{-1} - 10^{1}
Unsaturated Zone Hydraulic Conductivity Score	1	2	3	4	5

Table W.3

Unsaturated Zone Material	Clay	Clayey-Silt or Silt	Silty-Sand or Sand	Sandy-Gravel or Gravel	Karst
Unsaturated Zone Hydraulic Conductivity Score	1	2	3	4	5

Figure W.1. Net Infiltration



(Ref. 47)

WELLHEAD DATASHEET (continued)

PARAMETER		INSTRUCTIONS	SCORE
WD5	Unsaturated Zone Hydraulic Score	**If you know** the hydraulic conductivity of the unsaturated zone, then use **Table W.2** to determine the Unsaturated Zone Conductivity Score. For example, if the conductivity of the unsaturated zone is between 10^{-7} centimeters/second and 10^{-5} centimeters/second, then the Unsaturated Zone Conductivity Score is equal to 2. **If you do not know** the conductivity of the Unsaturated zone, then use **Table W.3** to determine the Unsaturated Zone Hydraulic Score as a function of the type of material in the unsaturated zone. For example, if the type of material in the unsaturated zone is sand, then the Unsaturated Zone Hydraulic Conductivity Score is equal to 3.	3
WD6	Saturated Zone Material	Either Silt, Sand, Gravel, or Karst as the Saturated Zone Material. Note that the Saturated Zone Material cannot be Clay.	Sand
WD7	Ground-Water Velocity Score	**If you know** the average ground-water velocity in the WHPA that takes into account the effects of pumping, then use **Table W.4** to determine the Ground-Water Velocity Score. For example, if the average ground-water velocity in the WHPA is between 10 meters/year and 10^3 meters/year, then the Ground-Water Velocity Score is equal to 3. **If you do not know** the ground-water velocity in the WHPA, then use **Table W.5** to determine the Ground-Water Velocity Score as a function of the type of material in the saturated zone. For example, if the type of material in the saturated zone is Gravel, then the Ground-Water Velocity Score is equal to 5. **Note** that if the Saturated Zone Material is Sand, then the Ground-Water Velocity Score depends on the pumping rate at the Wellhead. If the Saturated Zone material is Sand and the pumping rate is less than 45 million gallons/day	4

WELLHEAD DATASHEET (continued)

PARAMETER	INSTRUCTIONS	SCORE
	(30,000 gallons/minute), then the Ground-Water Velocity Score is equal to 3. If the Saturated Zone material is Sand and the pumping rate at the wellhead is greater than or equal to 45 million gallons/day (30,000 gallons/minute), then the Ground-Water Velocity Score is equal to 4.	

Table W.4

Ground-Water Velocity	(m/yr)		10^{-1} - 10^{1}	10^{1} - 10^{3}	10^{3} - 10^{5}	10^{5} - 10^{7}
	(ft/yr)		0.3 - 3.3	3.3×10^{1} - 3.3×10^{3}	3.3×10^{3} - 3.3×10^{5}	3.3×10^{5} - 3.3×10^{7}
Ground-Water Velocity Score			2	3	4	5

Table W.5

Saturated Zone Material		Silt	Sand	Gravel	Karst
Ground-Water Velocity Score		2	3 or 4*	5	5

* 3 if the wellhead pumping rate is less than 45 million gallons/day

4 if the wellhead pumping rate is greater than or equal to 45 million gallons/day

COMPLETED SHEETS FROM TASK II:

BLOCK I OF THE MASTER SCORESHEET, SEPTIC TANKS SYSTEM DATASHEET, AND TANKS DATASHEET

Master Scoresheet

BLOCK I		
TASK 2: IDENTIFY SOURCES		
#	Category	Name
1	SEPTIC SYSTEMS	GROUP OF SEPTIC SYSTEMS
2	TANKS	WIDGETS-R-US

BLOCK II						
CONTAMINANT/ MIXTURE	CARCINOGEN/ NON-CARCINOGEN	TASK 3 SOURCE ELEMENTS			TASK 4 TRANSPORT ELEMENTS	
		L_1	Q	T	L_2	A

BLOCK III					
TASK 5: ESTIMATE RISKS AND RANK SOURCES					
L	S	Risk	Overall Risk	Rank	Risk Level

L_1 = Likelihood of Release
Q = Quantity of Contaminant Released
T = Toxicity of Contaminant

L_2 = Likelihood of Reaching the Well
A = Attenuation Due to Transport

L = Likelihood = $L_1 + L_2$
S = Severity = Q + T + A
Risk = L + S
Overall Risk = Maximum Risk

Risk Level	Overall Risk
Low	Less than -4
Medium	Between -4 and 0
High	Greater than 0

SOURCE DATASHEET - SEPTIC TANK SYSTEMS

Step 5

Source #: 1

Author: A. Prudent

Source Name: Group of Septic Systems

Date: 6/17/91

Location: Fairlawn St.

PARAMETER	INSTRUCTIONS*	VALUE
DESIGN PARAMETERS		
SD1 Septic System Age	Estimate the average age of the septic systems in question	30 years
SD2 Total Sewage Throughput	See Note below.	40,191 thousand gallons/year (ref. 37)

Annual Sewage Throughput by Number and Type of Units Using Septic Systems (Thousands of Gallons per Year)

Septic System Type	Number of Units**				
	1-20	21-50	51-150	151-500	501 +
Houses	1,095	3,504	10,950	35,040	109,500
Apartments	438	1,402	4,380	10,402	43,800
Small Businesses	241	771	2,409	7,709	24,090

** For houses, the number of units is the number of houses.
For apartments, the number of units is the number of individual apartments.
For small businesses, the number of units is the number of individual small retailers such as gift and novelty stores and sporting goods stores.

Note: Use the table above to calculate the Total Sewage Throughput as a function of the number and type (house, apartment, or small business) of units using septic systems. For apartments, the number of units is the number of individual apartments using septic systems. For small businesses, include retailers whose throughput would include sanitary wastes only, such as gift and novelty stores and sporting goods stores. For example, if there is a cluster of about 25 houses, 60 apartments, and 20 small businesses that use septic systems, then the Total Sewage Throughput would equal 3,504 + 4,380 + 241, i.e., 8,125 thousand gallons/year.

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - SEPTIC TANK SYSTEMS (continued)

PARAMETER	INSTRUCTIONS*	VALUE
HYDROGEOLOGIC SETTINGS		
SD3 Distance Score	Use the table below to determine the Distance Score as a function of the distance from the source to the well (or to an abandoned well if one exists between the source and the well). Use the shortest distance from any one unit using a septic system to the well. For example, if the shortest distance between any one unit using a septic system and the well is 1,000 feet, then the Distance Score is equal to 2.	2

Distance Scoring Form

Distance from Source to Well	(Miles)	0 - .12	.12 - .25	.25 - .5	.5 - 1.0	1.0 - 3.0	3.0 - 5.0
	(Feet)	0 - 635	635 - 1320	1320 - 2640	2640 - 5280	5280 - 15,840	15,840 - 26,400
	(Meters)	0 - 193	193-402	402 - 805	805 - 1610	1610 - 4829	4829 - 8040
Distance Score		1	2	3	4	5	6

SD4 Does the source discharge directly to a conduit system (e.g., pipes or utility chase) that could transport contaminants directly to the well?	Yes or No	No

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - SEPTIC TANK SYSTEMS (continued)

PARAMETER	INSTRUCTIONS*	VALUE

CONTAMINANT PARAMETERS

SD5 Contaminant Data

Use Contaminant Forms S.1 or S.2 to complete the Contaminant Data Table below. Refer to Task 2 of the User's Guide for additional guidance.

Contaminant Data Table

	Contaminant/Mixture Score	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
1	Nitrates	-1.5	-0.7	H	L
2					
3					

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - TANKS

Step 5

Source #: 2

Author: A. Prudent

Source Name: Widgets-R-Us

Date: 6/17/91

Location: Oak St.

PARAMETER	INSTRUCTIONS*	VALUE
DESIGN PARAMETERS		
SD1 Number of Tanks	You may want to group tanks containing similar contaminants and of similar size, design, age and distance from the wellhead. You need not determine the exact number of tanks; rather, determine if the number of tanks is within one of the following ranges: 1, 2-5, 6-25, 26-75, or > 75.	1
SD2 Tank Size	Enter Small, Medium, or Large for the size of each tank or group. Small = < 5,000 gallons each Medium = 5,000 - 30,000 gallons each Large = > 30,000 gallons each	Med.
SD3 Tank Design	Enter the tank number using the information in the table on the next page (Refs. 12 and 25).	7

* For additional guidance, especially for contaminant-specific data (SD7), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - TANKS (continued)

PARAMETER	INSTRUCTIONS*	VALUE

Tank Design

Design	Description
A.	**Hazardous Waste, Chemical, and Petroleum Storage Tanks**
1	Above-ground bare steel tank resting on cradles on a concrete pad with curbing. The tank capacity is less than or equal to 30,000 gallons (small or medium).
2	Above-ground bare steel tank resting on-grade on a concrete pad with curbing. The tank capacity is greater than or equal to 30,000 gallons (large).
3	In-ground concrete tank with an open top at ground level.
4	Below-ground bare steel tank.
5	Below-ground double-walled steel tank with interstitial monitoring.
6	Below-ground $STiP_3$ tank (cathodically protected).
7	Below-ground fiber-reinforced plastic (FRP) tank.
B.	**Hazardous Waste and Wastewater Treatment Tanks**
8	Above-ground bare steel tank resting on cradles on a concrete pad with curbing. The tank capacity is less than or equal to 30,000 gallons (small or medium).
9	Above-ground bare steel tank resting on-grade on a concrete pad with curbing. The tank capacity is greater than or equal to 30,000 gallons (large).
10	In-ground concrete tank with an open top at ground level.
C.	**Hazardous Waste Small Quantity Generator and Farm Storage Tanks**
11	Above-ground bare steel tank resting on cradles.
12	Below-ground bare steel tank.

* For additional guidance, especially for contaminant-specific data (SD7), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - TANKS (continued)

PARAMETER	INSTRUCTIONS*	VALUE
SD4 Tank Age	Enter the age of the tank or the average age of the tanks in the group.	1 year(s)
HYDROGEOLOGIC SETTINGS		
SD5 Distance Score	Use the table below to determine the Distance Score as a function of the shortest distance from the tank(s) to the well (or to the abandoned well if one exists between the tank(s) and the well). For example, if the shortest distance between the tank(s) and the well is between 1/2 and 1 mile, then the Distance Score is equal to 4.	3

Distance Scoring Form

Distance from Source to Well							
	(Miles)	0 - .12	.12 - .25	.25 - .5	.5 - 1.0	1.0 - 3.0	3.0 - 5.0
	(Feet)	0 - 635	635 - 1320	1320 - 2640	2640 - 5280	5280 - 15,840	15,840 - 26,400
	(Meters)	0 - 193	193-402	402 - 805	805 - 1610	1610 - 4829	4829 - 8040
Distance Score		1	2	3	4	5	6

SD6 Does the source discharge directly to a conduit system (e.g., pipes or utility chase) that could transport contaminants directly to the well?	Yes or No	No

* For additional guidance, especially for contaminant-specific data (SD7), refer to the User's Guide. (Chapter 2).

SOURCE DATASHEET - TANKS (continued)

PARAMETER	INSTRUCTIONS*	VALUE

CONTAMINANT PARAMETERS

SD7 Contaminant Data

Use Contaminant Forms S.1 or S.2 to complete the Contaminant Data Table below. Refer to Task 2 of the User's Guide for additional guidance.

Contaminant Data Table

	Contaminant/Mixture Score	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
1	Chloroform	1.2	1.0	H	M
2	1,1,1-Trichloroethane	-0.5	1.5	M	M
3					

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide. (Chapter 2).

COMPLETED SHEETS FROM TASK III:

SEPTIC TANKS SYSTEM WORKSHEET,
TANKS WORKSHEET, AND
THE FIRST PART OF BLOCK II OF THE MASTER SCORESHEET

Step 6

SOURCE # 1

SOURCE WORKSHEET - SEPTIC TANK SYSTEMS

STEP	INSTRUCTIONS	SCORE

LIKELIHOOD OF RELEASE (L_1)

Step 1 Likelihood of Release (L_1) Score

Set $L_1 = 0$.

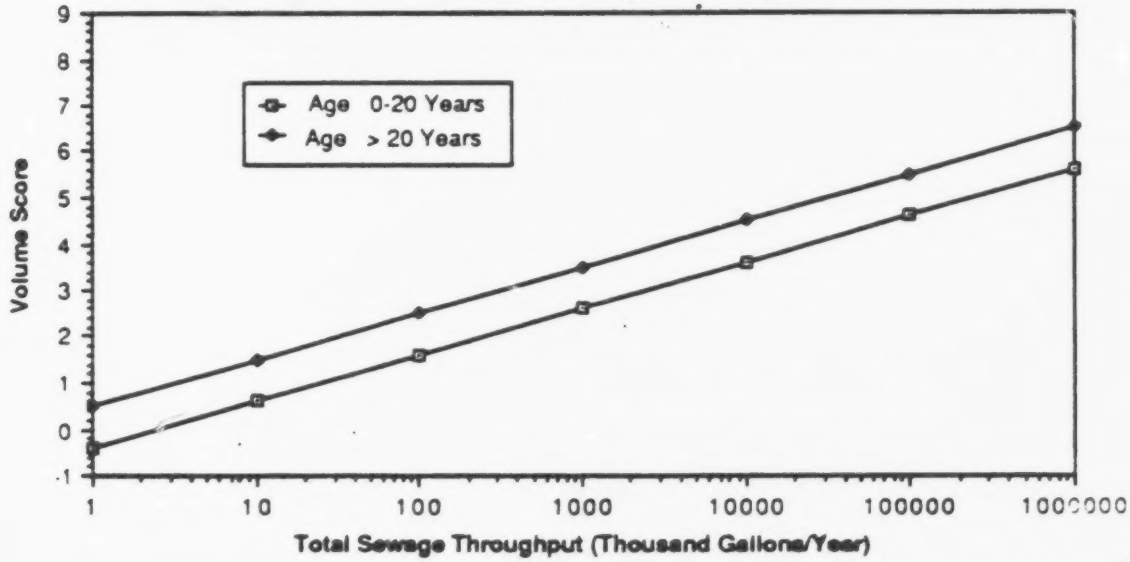
Likelihood of Release (L_1) Score = 0

QUANTITY (Q)

Step 2 Determine the Volume Score

Use the graph below to determine the Volume Score as a function of the Total Sewage Throughput (SD2) and the Septic System Age (SD1).

Volume Score by Total Sewage Throughput and Septic System Age



Volume Score: 5

(Ref. 26)

SOURCE WORKSHEET - SEPTIC TANK SYSTEMS (continued)

STEP	INSTRUCTIONS	SCORE

Step 3 Compute the Quantity Score (Q) for Each Contaminant

Quantity Score (Q) = Volume Score (Step 2)
+ Concentration Score (SD5)

Contaminant or Contaminant Mixture	Quantity Score (Q)
(1) Nitrates	4.3
(2)	
(3)	

Step 6

SOURCE # 2

SOURCE WORKSHEET - TANKS

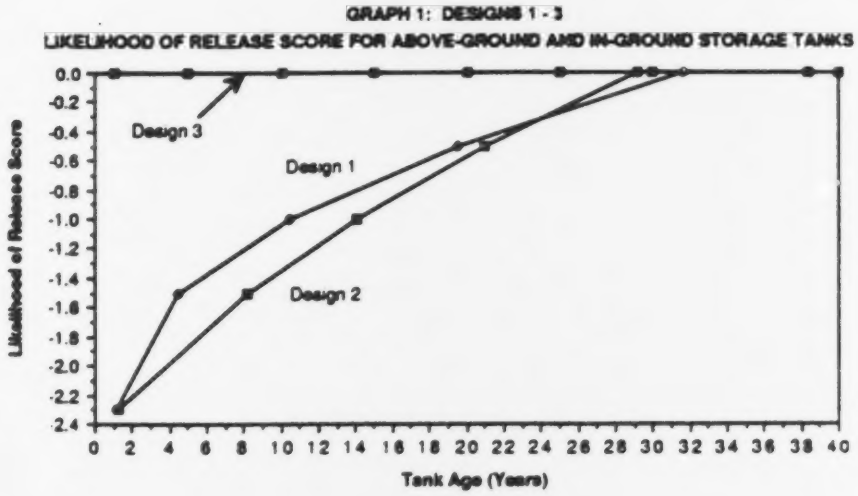
STEP	INSTRUCTIONS	SCORE

LIKELIHOOD OF RELEASE (L_1)

Step 1 Likelihood of Release (L_1) Score

Use the graphs on the next page to determine the Likelihood of Release Score (L_1) as a function of Tank Design (SD3) and Tank Age (SD4). For Designs 1-3, use the first graph; for Designs 4-7, use the second graph; for Designs 8-10, use the third graph; and for Designs 11-12, use the fourth graph. Note that if your Tank Design is 3 or 10, $L_1 = 0$. If Tank Age is greater than 40 years, set the Likelihood of Release Score to 0.

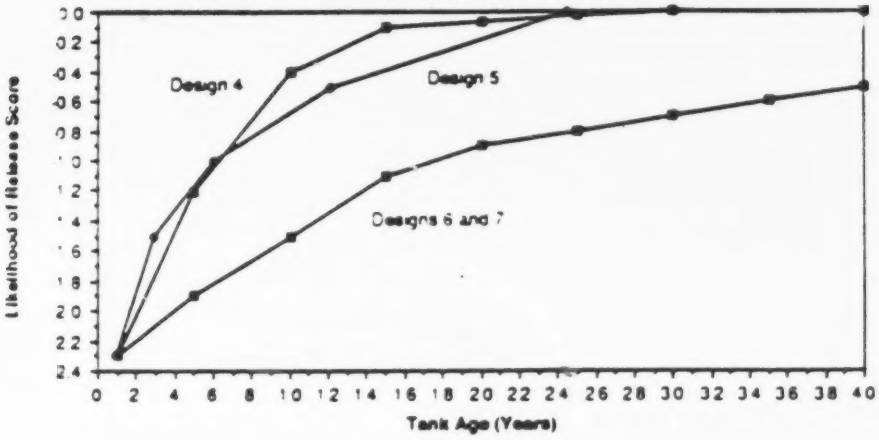
Likelihood of Release (L_1) Score = -2.3
(Ref. 25)



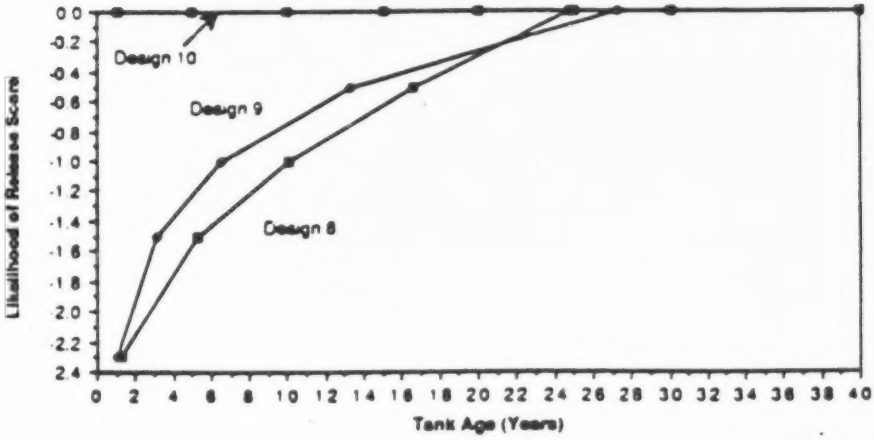
SOURCE WORKSHEET - TANKS (continued)

STEP	INSTRUCTIONS	SCORE

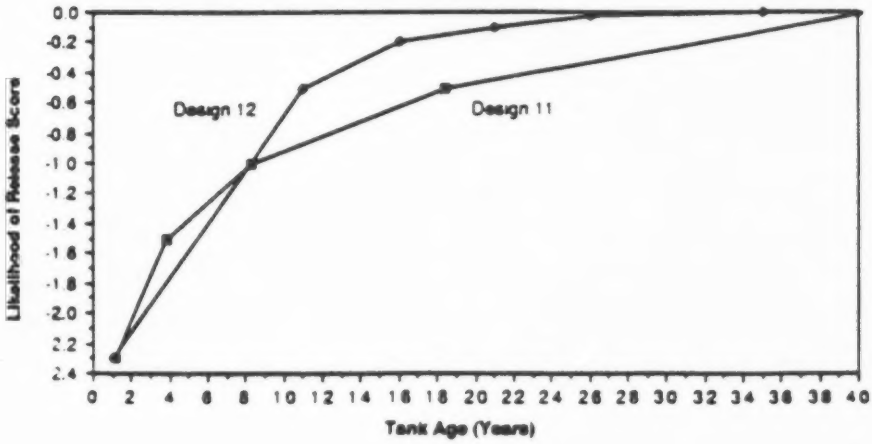
GRAPH 2: DESIGNS 4 - 7
LIKELIHOOD OF RELEASE SCORE FOR BELOW-GROUND STORAGE TANKS



GRAPH 3: DESIGNS 8 - 10
LIKELIHOOD OF RELEASE SCORE FOR TREATMENT TANKS



GRAPH 4: DESIGNS 11 - 12
LIKELIHOOD OF RELEASE SCORE FOR SQG AND FARM STORAGE TANKS



SOURCE WORKSHEET - TANKS (continued)

STEP	INSTRUCTIONS	SCORE

QUANTITY (Q)

Step 2 Compute the Volume Score

Use the graph below to determine the Volume Score as a function of the Number of Tanks (SD1), Tank Size (SD2), and Tank Design (SD3).

Volume Score for Storage and Treatment Tanks

Tank Design	Number of Tanks														
	1			2 - 5			6 - 25			26 - 75			>75		
	Tank Size			Tank Size			Tank Size			Tank Size			Tank Size		
	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L
1	-0.2	-0.1	-	0.2	0.3	-	1.4	1.5	-	1.9	2	-	2.2	2.3	-
2	-	-	0.9		-	1.3	-	-	2.5	-	-	3	-	-	3.3
3	-0.7	-0.6	-0.4	-0.2	-0.1	0.1	1	1.1	1.3	1.5	1.6	1.8	1.8	1.9	2.1
4	0.3	0.4	-	0.7	0.8	-	1.9	2	-	2.4	2.5	-	2.7	2.8	-
5	-1.2	-1	-	-0.7	-0.5	-	0.5	0.7	-	1	1.2	-	1.3	1.5	-
6	0.9	1	-	1.4	1.5	-	2.6	2.7	-	3.1	3.2	-	3.4	3.5	-
7	0.4	0.5	0.6	0.9	1	1.1	2.1	2.2	2.3	2.6	2.7	2.8	2.9	3	3.1
8	-1	-0.8	-	-0.5	-0.3	-	0.7	0.9	-	1.2	1.4	-	1.5	1.7	-
9	-	-	0.2	-	-	0.7	-	-	1.9	-	-	2.4	-	-	2.7
10	-0.1	-0.1	0.1	0.3	-0.3	0.5	1.5	1.5	1.7	2	2	2.2	2.3	2.3	2.5
11	-0.7	-	-	-0.3	-	-	0.9	-	-	1.4	-	-	1.7	-	-
12	-1.3	-	-	-0.9	-	-	0.9	-	-	0.8	-	-	1.1	-	-

-- Indicates not applicable

S = Small, M = Medium, L = Large

Volume Score: 0.5
(Ref. 25)

SOURCE WORKSHEET - TANKS (continued)

STEP	INSTRUCTIONS	SCORE

Step 3 Compute the Quantity Score (Q) for Each Contaminant

Quantity Score (Q) = Concentration Score (SD7)
+ Volume Score (Step 2)

Contaminant or Contaminant Mixture	Quantity Score (Q)
(1) Chloroform	1.5
(2) 1,1,1-Trichloroethane	2.0
(3)	

Master Scoresheet

BLOCK I		
TASK 2 IDENTIFY SOURCES		
#	Category	Name
1	SEPTIC SYSTEMS	GROUP OF SEPTIC SYSTEMS
2	TANKS	WIDGETS-R-US

BLOCK II						
CONTAMINANT/ MIXTURE	CARCINOGEN/ NON-CARCINOGEN	TASK 3 SOURCE ELEMENTS			TASK 4 TRANSPORT ELEMENTS	
		L_1	Q	T	L_2	A
NITRATES	NON-CARCIN	0	4.3	-1.5		
CHLOROFORM	CARCIN		1.5	1.2		
1,1,1-TCA	NON-CARCIN	-2.3	2	-0.5		

BLOCK III					
TASK 5 ESTIMATE RISKS AND RANK SOURCES					
L	S	Risk	Overall Risk	Rank	Risk Level

L_1 = Likelihood of Release
Q = Quantity of Contaminant Released
T = Toxicity of Contaminant

L_2 = Likelihood of Reaching the Well
A = Attenuation Due to Transport

L = Likelihood = $L_1 + L_2$
S = Severity = Q + T + A
Risk = L + S
Overall Risk = Maximum Risk

Risk Level	Overall Risk
Low	Less than -4
Medium	Between -4 and 0
High	Greater than 0

COMPLETED SHEETS FROM TASK IV:

TRANSPORT WORKSHEET FOR SEPTIC SYSTEMS,
TRANSPORT WORKSHEET FOR TANKS, AND
THE SECOND PART OF BLOCK II OF THE MASTER SCORESHEET

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Adjusted Hydraulic Conductivity and Velocity Scores

Unsaturated Zone Hydraulic Conductivity Score or Ground-Water Velocity Score	Contaminant Mobility		
	L	M	H
1	1	1	1
2	1	1	2
3	1	2	3
4	2	3	4
5	3	4	5

	CONTAMINANT 1	2	3
Hydraulic Conductivity Score =	3		
Velocity Score =	4		

Quick Exit

If the source discharges directly to a conduit system that could transport contaminants directly to the well (SD), then for each contaminant at the source:

Skip Steps 3 and 4, set the Likelihood of Reaching the Well (L_2) in Step 5 equal to 0, and go to Step 6.

Step 8

SOURCE # 1

TRANSPORT WORKSHEET

STEP	INSTRUCTIONS	SCORE

This worksheet* provides guidance for determining scores for each step in the transport calculations. In this guidance, the labels in parentheses refer to three sources of scores:

- scores from a step in the Wellhead Datasheet, e.g., (WD2)
- scores from the Source Datasheet, i.e., (SD)
- scores from a step in this Transport Worksheet, e.g., (Step 5).

Step 1 Compute Timeframe

Timeframe (years) = Age of Source (SD)
+ Planning Period (WD1)

Timeframe = 180

CONTAMINANT-SPECIFIC STEPS

Steps 2 through 8 will help you calculate two risk elements for each contaminant or contaminant/mixture at the source: Likelihood of Reaching the Well (L_2) and Attenuation Due to Transport (A). For a given source, L_2 and A vary only with the contaminant's mobility and persistence. Therefore, you need only recompute L_2 and A by completing Steps 2 through 8 for contaminants with different values of mobility and/or persistence.

Step 2 Determine Hydraulic Conductivity and Velocity Scores

Use the following table to determine the Hydraulic Conductivity and Velocity Scores as a function of the Contaminant Mobility (SD) and either the Unsaturated Zone Hydraulic Conductivity score (WD5) or the Ground-Water Velocity score (WD7), respectively. For example, if Contaminant Mobility is Medium and the Unsaturated Zone Hydraulic Conductivity score is 4, then the Hydraulic Conductivity Score is equal to 3.

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* References 17, 43, 57, and 73 were used to develop this worksheet.

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Step 3 Determine Unsaturated Zone and Saturated Zone Time of Travel (TOT) Categories

Use the following table to determine the Unsaturated Zone TOT Category as a function of the Depth to Aquifer score (WD2) and the Hydraulic Conductivity score (Step 2). For example, if the Depth to Aquifer score is 1.5 and the Hydraulic Conductivity Score is 2, then the Unsaturated Zone TOT Category is D.

Unsaturated Zone Time of Travel Category

Depth to Aquifer Score	Hydraulic Conductivity Score				
	1	2	3	4	5
0.3	E	B	A	A	A
1	F	C	A	A	A
1.5	F	D	B	A	A
2.2	F	D	B	A	A

CONTAMINANT

	1	2	3
Unsaturated Zone TOT Category =	A		

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE
	Likewise, use the following table to determine the Saturated Zone TOT Category as a function of the Distance score (SD) and Velocity Score (Step 2).	

Saturated Zone Time of Travel Categories

Distance Score	Velocity Score			
	2	3	4	5
1	D	B	A	A
2	D	B	A	A
3	E	B	A	A
4	F	C	A	A
5	F	C	A	A
6	F	C	A	A

Note: If the Velocity Score is 1, then the Saturated Zone Time of Travel Category is Equal to F

	CONTAMINANT		
	1	2	3
Saturated Zone TOT Category =	A	____	____

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Step 4 Determine Unsaturated Zone and Saturated Zone Likelihoods (L_U) and (L_S)

Use the following table to find the Unsaturated Zone Likelihood (L_U) as a function of the Unsaturated Zone TOT Category (Step 3) and Timeframe (Step 1).

Unsaturated and Saturated Zone Likelihood Scores (L_U and L_S)

Time of Travel Category	Timeframe (Years)			
	1-10	11-100	101-500	501-1000
A	0	0	0	0
B	-0.3	0	0	0
C	-3	-0.3	-0.1	0
D	-100	-0.9	-0.3	-0.1
E	-100	-100	-0.3	-0.3
F	-100	-100	-100	-100

CONTAMINANT

	1	2	3
Unsaturated Zone Likelihood (L_U) =	0	____	____

Use the same table to determine the Saturated Zone Likelihood (L_S) as a function of the Saturated Zone TOT Category (Step 3) and Timeframe (Step 1).

Saturated Zone Likelihood (L_S) =	0	____	____

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Step 5 Compute Likelihood of Reaching the Well (L_2)

Set

$$L_2 = L_U \text{ (Step 4)} + L_3 \text{ (Step 4)}$$

Note: As the Likelihood of Reaching the Well (L_2) score becomes very low (i.e., less than -10), the estimated risk approaches a negligible value.

	CONTAMINANT		
	1	2	3
Likelihood of Reaching the Well (L_2) =	0	____	____

Step 6 Determine Unsaturated Zone Attenuation (A_U)

Use the following table to determine the Unsaturated Zone Attenuation (A_U) as a function of the Depth to Aquifer score (WD2), the Hydraulic Conductivity score (Step 2), and Contaminant Persistence (SD). For example, if the Depth to Aquifer Score is 1.5, the Hydraulic Conductivity score is 2, and the Contaminant Persistence is High, then the Unsaturated Zone Attenuation (A_U) is equal to 0.

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Unsaturated Zone Attenuation Scores (A_U)

Hydraulic Conductivity Score	Contaminant Persistence	Depth to Aquifer Score			
		0.3	1.0	1.5	2.2
1	L	-100	-100	-100	-100
	M	-6	-31.2	-94.8	-100
	H	-0.2	-1.2	-3.6	-12.0
2	L	-100	-100	-100	-100
	M	-0.1	-0.3	-0.9	-3.1
	H	0	0	0	-0.1
3	L	-0.2	-1.2	-3.6	-12.0
	M	0	0	0	0
	H	0	0	0	0
4	L	0	0	0	-0.1
	M	0	0	0	0
	H	0	0	0	0

Note: If the Hydraulic Conductivity Score is 5, then A_U is equal to 0 (regardless of the contaminant persistence and depth to aquifer scores).

CONTAMINANT

	1	2	3
Unsaturated Zone Attenuation (A_U) =	-1.2	____	____

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Step 7 Compute Saturated Zone Attenuation (A_s)

Use the table on the next page to determine the Unadjusted score as a function of the Saturated Zone Material (WD6), the Distance score (SD), the Velocity score (Step 2), and Contaminant Persistence (SD). For example, if the Saturated Zone Material is Sand, the Design score is 2, the Velocity score is 3, and the Contaminant Persistence is High, then the Unadjusted score is equal to -0.6.

Then set

A_s = Unadjusted score (from table) 3.1 - 0.3 = -3.4
- Aquifer Thickness score (WD3).

You must subtract the Aquifer Thickness score from the Unadjusted score to determine A_s.

	CONTAMINANT 1	2	3
Saturated Zone Attenuation (A_s) =	-3.4	____	____

Step 8 Compute Attenuation Due to Transport (A)

Set

-1.2 + -3.4 = -4.6

A = A_U (Step 6) + A_s (Step 7).

Note: Low values of the Attenuation Due to Transport score (A) generally cause the Potential Severity of Well Contamination to be relatively small. For a value less than -1.0, the potential Severity of Well Contamination generally is negligible.

	CONTAMINANT 1	2	3
Attenuation due to Transport (A) =	-4.6	____	____

Unadjusted Saturated Zone Attenuation Scores

Saturated Zone Material

VS	CP	SILT						SAND						GRAVEL						KARST					
		Distance Score						Distance Score						Distance Score						Distance Score					
		1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
2	L	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100
	M	-2.0	-10.0	-22.0	-45.8	-100	-100	-2.3	-10.2	-22.3	-46.1	-100	-100	-2.7	-10.6	-22.6	-46.4	-100	-100	-3.8	-11.9	-23.9	-47.7	-100	-100
	H	1.8	1.3	0.7	-0.3	-3.3	-8.0	1.6	0.9	0.4	-0.7	-3.7	-8.3	1.2	0.6	0.0	-1.0	-4.0	-8.7	0.0	-0.5	-1.1	-2.1	-8.1	-9.8
3	L	-15.1	-45.7	-91.5	-100	-100	-100	-15.4	-46.0	-91.8	-100	-100	-100	-15.7	-46.3	-92.6	-100	-100	-100	-1.8	-15.0	-47.6	-93.4	-100	-100
	M	0.0	-0.3	-0.6	-1.0	-1.9	-3.3	-0.3	-0.7	-0.9	-1.4	-2.3	-3.6	-0.7	-1.0	-1.3	-1.7	-2.6	-4.0	-1.8	-2.1	-2.4	-2.8	-3.7	-5.1
	H	0.0	-0.2	-0.4	-0.5	-0.8	-1.0	-0.3	-0.6	-0.7	-0.9	-1.2	-1.3	-0.7	-0.9	-1.1	-1.2	-1.5	-1.7	-1.8	-2.0	-2.2	-2.3	-2.6	-2.8
4	L	-2.1	-2.7	-3.3	-4.3	-7.3	-11.9	-2.3	-3.1	-3.6	-4.7	-7.7	-12.2	-2.7	-3.4	-4.0	-5.0	-8.0	-12.5	-3.8	-4.5	-5.1	-8.1	-891	-13.7
	M	-2.0	-2.2	-2.4	-2.5	-2.7	-2.9	-2.3	-2.6	-2.7	-2.9	-3.1	-3.2	-2.7	-2.9	-3.1	-3.2	-3.4	-3.6	-3.8	-4.0	-4.2	-4.3	-4.5	-4.7
	H	-2.0	-2.2	-2.4	-2.5	-2.7	-2.9	-2.3	-2.6	-2.7	-2.9	-3.1	-3.2	-2.7	-2.9	-3.1	-3.2	-3.4	-3.6	-3.8	-4.0	-4.2	-4.3	-4.5	-4.7
5	L	-4.0	-4.2	-4.4	-4.5	-4.8	-5.0	-4.3	-4.5	-4.7	-4.9	-5.2	-5.3	-4.7	-4.9	-5.1	-5.2	-5.5	-5.7	-5.8	-6.0	-6.2	-6.3	-6.6	-6.8
	M	-4.0	-4.2	-4.4	-4.5	-4.7	-4.9	-4.3	-4.6	-4.7	-4.9	-5.1	-5.2	-4.7	-4.9	-5.1	-5.2	-5.4	-5.6	-5.8	-6.0	-6.2	-6.3	-6.5	-6.7
	H	-4.0	-4.2	-4.4	-4.5	-4.7	-4.9	-4.3	-4.6	-4.7	-4.9	-5.1	-5.2	-4.7	-4.9	-5.1	-5.2	-5.4	-5.6	-5.8	-6.0	-6.2	-6.3	-6.5	-6.7

Note: VS = Velocity Score, CP = Contaminant Persistence

If the velocity score is 1, then the Unadjusted Saturated Zone Attenuation Score is equal to -100 (regardless of contaminant persistence, saturated zone material and distance score).

Step 8

SOURCE # 2

TRANSPORT WORKSHEET

STEP	INSTRUCTIONS	SCORE

This worksheet* provides guidance for determining scores for each step in the transport calculations. In this guidance, the labels in parentheses refer to three sources of scores:

- scores from a step in the Wellhead Datasheet, e.g., (WD2)
- scores from the Source Datasheet, i.e., (SD)
- scores from a step in this Transport Worksheet, e.g., (Step 5).

Step 1 Compute Timeframe

Timeframe (years) = Age of Source (SD)
+ Planning Period (WD1)

Timeframe = 151

CONTAMINANT-SPECIFIC STEPS

Steps 2 through 8 will help you calculate two risk elements for each contaminant or contaminant/mixture at the source: Likelihood of Reaching the Well (L_2) and Attenuation Due to Transport (A). For a given source, L_2 and A vary only with the contaminant's mobility and persistence. Therefore, you need only recompute L_2 and A by completing Steps 2 through 8 for contaminants with different values of mobility and/or persistence.

Step 2 Determine Hydraulic Conductivity and Velocity Scores

Use the following table to determine the Hydraulic Conductivity and Velocity Scores as a function of the Contaminant Mobility (SD) and either the Unsaturated Zone Hydraulic Conductivity score (WD5) or the Ground-Water Velocity score (WD7), respectively. For example, if Contaminant Mobility is Medium and the Unsaturated Zone Hydraulic Conductivity score is 4, then the Hydraulic Conductivity Score is equal to 3.

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* References 17, 43, 57, and 73 were used to develop this worksheet.

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Adjusted Hydraulic Conductivity and Velocity Scores

Unsaturated Zone Hydraulic Conductivity Score or Ground-Water Velocity Score	Contaminant Mobility		
	L	M	H
1	1	1	1
2	1	1	2
3	1	2	3
4	2	3	4
5	3	4	5

CONTAMINANT

	1	2	3
Hydraulic Conductivity Score =	3	2	
Velocity Score =	4	3	

Quick Exit

If the source discharges directly to a conduit system that could transport contaminants directly to the well (SD), then for each contaminant at the source:

Skip Steps 3 and 4, set the Likelihood of Reaching the Well (L_2) in Step 5 equal to 0, and go to Step 6.

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Step 3 Determine Unsaturated Zone and Saturated Zone Time of Travel (TOT) Categories

Use the following table to determine the Unsaturated Zone TOT Category as a function of the Depth to Aquifer score (WD2) and the Hydraulic Conductivity score (Step 2). For example, if the Depth to Aquifer score is 1.5 and the Hydraulic Conductivity Score is 2, then the Unsaturated Zone TOT Category is D.

Unsaturated Zone Time of Travel Category

Depth to Aquifer Score	Hydraulic Conductivity Score				
	1	2	3	4	5
0.3	E	B	A	A	A
1	F	C //	A /	A	A
1.5	F	D	B	A	A
2.2	F	D	B	A	A

CONTAMINANT

	1	2	3
Unsaturated Zone TOT Category =	A	C	

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE
	Likewise, use the following table to determine the Saturated Zone TOT Category as a function of the Distance score (SD) and Velocity Score (Step 2).	

Saturated Zone Time of Travel Categories

Distance Score	Velocity Score			
	2	3	4	5
1	D	B	A	A
2	D	B	A	A
3	E	B	A	A
4	F	C	A	A
5	F	C	A	A
6	F	C	A	A

Note: If the Velocity Score is 1, then the Saturated Zone Time of Travel Category is Equal to F

CONTAMINANT

	1	2	3
Saturated Zone TOT Category =	A	B	

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Step 4 Determine Unsaturated Zone and Saturated Zone Likelihoods (L_U) and (L_S)

Use the following table to find the Unsaturated Zone Likelihood (L_U) as a function of the Unsaturated Zone TOT Category (Step 3) and Timeframe (Step 1).

Unsaturated and Saturated Zone Likelihood Scores (L_U and L_S)

Time of Travel Category	Timeframe (Years)			
	1-10	11-100	101-500	501-1000
u A s	0	0	u / 0 / s	0
B s	-0.3	0	0 / s	0
u C	-3	-0.3	u // -0.1	0
D	-100	-0.9	-0.3	-0.1
E	-100	-100	-0.3	-0.3
F	-100	-100	-100	-100

CONTAMINANT

	1	2	3
Unsaturated Zone Likelihood (L_U) =	0	-0.1	___

Use the same table to determine the Saturated Zone Likelihood (L_S) as a function of the Saturated Zone TOT Category (Step 3) and Timeframe (Step 1).

Saturated Zone Likelihood (L_S) =	0	0	___

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Step 5 Compute Likelihood of Reaching the Well (L_2)

Set

$$L_2 = L_U \text{ (Step 4)} + L_3 \text{ (Step 4)}$$

Note: As the Likelihood of Reaching the Well (L_2) score becomes very low (i.e., less than -10), the estimated risk approaches a negligible value.

	CONTAMINANT		
	1	2	3
Likelihood of Reaching the Well (L_2) =	0	-0.1	____

Step 6 Determine Unsaturated Zone Attenuation (A_U)

Use the following table to determine the Unsaturated Zone Attenuation (A_U) as a function of the Depth to Aquifer score (WD2), the Hydraulic Conductivity score (Step 2), and Contaminant Persistence (SD). For example, if the Depth to Aquifer Score is 1.5, the Hydraulic Conductivity score is 2, and the Contaminant Persistence is High, then the Unsaturated Zone Attenuation (A_U) is equal to 0.

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Unsaturated Zone Attenuation Scores (A_U)

Hydraulic Conductivity Score	Contaminant Persistence	Depth to Aquifer Score			
		0.3	1.0	1.5	2.2
1	L	-100	-100	-100	-100
	M	-6	-31.2	-94.8	-100
	H	-0.2	-1.2	-3.6	-12.0
2	L	-100	-100	-100	-100
	M	-0.1	-0.3 //	-0.9	-3.1
	H	0	0	0	-0.1
3	L	-0.2	-1.2	-3.6	-12.0
	M	0	0 /	0	0
	H	0	0	0	0
4	L	0	0	0	-0.1
	M	0	0	0	0
	H	0	0	0	0

Note: If the Hydraulic Conductivity Score is 5, then A_U is equal to 0 (regardless of the contaminant persistence and depth to aquifer scores).

CONTAMINANT

	1	2	3
Unsaturated Zone Attenuation (A_U) =	0	-0.3	____

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Step 7 Compute Saturated Zone Attenuation (A_s)

Use the table on the next page to determine the Unadjusted score as a function of the Saturated Zone Material (WD6), the Distance score (SD), the Velocity score (Step 2), and Contaminant Persistence (SD). For example, if the Saturated Zone Material is Sand, the Design score is 2, the Velocity score is 3, and the Contaminant Persistence is High, then the Unadjusted score is equal to -0.6.

Then set -2.7 - 0.3 = -3

A_s = Unadjusted score (from table) - Aquifer Thickness score (WD3). -0.9 - 0.3 = -1.2

You must subtract the Aquifer Thickness score from the Unadjusted score to determine A_s.

	CONTAMINANT 1	2	3
Saturated Zone Attenuation (A_s) =	-3	-1.2	____

Step 8 Compute Attenuation Due to Transport (A)

Set

$A = A_U$ (Step 6) + A_s (Step 7).

Note: Low values of the Attenuation Due to Transport score (A) generally cause the Potential Severity of Well Contamination to be relatively small. For a value less than -1.0, the potential Severity of Well Contamination generally is negligible.

	CONTAMINANT 1	2	3
Attenuation due to Transport (A) =	-3	-1.5	____

Unadjusted Saturated Zone Attenuation Scores

Saturated Zone Material

VS	CP	SILT						SAND						GRAVEL						KARST					
		Distance Score						Distance Score						Distance Score						Distance Score					
		1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
2	L	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100
	M	-2.0	-10.0	-22.0	-45.8	-100	-100	-2.3	-10.2	-22.3	-46.1	-100	-100	-2.7	-10.6	-22.6	-46.4	-100	-100	-3.8	-11.9	-23.9	-47.7	-100	-100
	H	1.8	1.3	0.7	-0.3	-3.3	-8.0	1.6	0.9	0.4	-0.7	-3.7	-8.3	1.2	0.6	0.0	-1.0	-4.0	-8.7	0.0	-0.5	-1.1	-2.1	-8.1	-9.8
3	L	-15.1	-45.7	-91.5	-100	-100	-100	-15.4	-46.0	-91.8	-100	-100	-100	-15.7	-46.3	-92.6	-100	-100	-100	-1.8	-15.0	-47.6	-93.4	-100	-100
	M	0.0	-0.3	-0.6	-1.0	-1.9	-3.3	-0.3	-0.7	-0.9	-1.4	-2.3	-3.6	-0.7	-1.0	-1.3	-1.7	-2.6	-4.0	-1.8	-2.1	-2.4	-2.8	-3.7	-5.1
	H	0.0	-0.2	-0.4	-0.5	-0.8	-1.0	-0.3	-0.6	-0.7	-0.9	-1.2	-1.3	-0.7	-0.9	-1.1	-1.2	-1.5	-1.7	-1.8	-2.0	-2.2	-2.3	-2.6	-2.8
4	L	-2.1	-2.7	-3.3	-4.3	-7.3	-11.9	-2.3	-3.1	-3.6	-4.7	-7.7	-12.2	-2.7	-3.4	-4.0	-5.0	-8.0	-12.5	-3.8	-4.5	-5.1	-8.1	-891	-13.7
	M	-2.0	-2.2	-2.4	-2.5	-2.7	-2.9	-2.3	-2.6	-2.7	-2.9	-3.1	-3.2	-2.7	-2.9	-3.1	-3.2	-3.4	-3.6	-3.8	-4.0	-4.2	-4.3	-4.5	-4.7
	H	-2.0	-2.2	-2.4	-2.5	-2.7	-2.9	-2.3	-2.6	-2.7	-2.9	-3.1	-3.2	-2.7	-2.9	-3.1	-3.2	-3.4	-3.6	-3.8	-4.0	-4.2	-4.3	-4.5	-4.7
5	L	-4.0	-4.2	-4.4	-4.5	-4.8	-5.0	-4.3	-4.5	-4.7	-4.9	-5.2	-5.3	-4.7	-4.9	-5.1	-5.2	-5.5	-5.7	-5.8	-6.0	-6.2	-6.3	-6.6	-6.8
	M	-4.0	-4.2	-4.4	-4.5	-4.7	-4.9	-4.3	-4.6	-4.7	-4.9	-5.1	-5.2	-4.7	-4.9	-5.1	-5.2	-5.4	-5.6	-5.8	-6.0	-6.2	-6.3	-6.5	-6.7
	H	-4.0	-4.2	-4.4	-4.5	-4.7	-4.9	-4.3	-4.6	-4.7	-4.9	-5.1	-5.2	-4.7	-4.9	-5.1	-5.2	-5.4	-5.6	-5.8	-6.0	-6.2	-6.3	-6.5	-6.7

Note: VS = Velocity Score, CP = Contaminant Persistence

If the velocity score is 1, then the Unadjusted Saturated Zone Attenuation Score is equal to -100 (regardless of contaminant persistence, saturated zone material and distance score).

Master Scoresheet

BLOCK I		
TASK 2: IDENTIFY SOURCES		
#	Category	Name
1	SEPTIC SYSTEMS	GROUP OF SEPTIC SYSTEMS
2	TANKS	WIDGETS-R-US

BLOCK II						
		TASK 3 SOURCE ELEMENTS			TASK 4 TRANSPORT ELEMENTS	
CONTAMINANT/ MIXTURE	CARCINOGEN/ NON-CARCINOGEN	L_1	Q	T	L_2	A
NITRATES	NON-CARCIN	0	4.3	-1.5	0	-4.6
CHLOROFORM	CARCIN		1.5	1.2	0	-3
1,1,1-TCA	NON-CARCIN	-2.3	2	-0.5	-0.1	-1.5

BLOCK III					
TASK 5: ESTIMATE RISKS AND RANK SOURCES					
L	S	Risk	Overall Risk	Rank	Risk Level

L_1 = Likelihood of Release
Q = Quantity of Contaminant Released
T = Toxicity of Contaminant

L_2 = Likelihood of Reaching the Well
A = Attenuation Due to Transport

L = Likelihood = $L_1 + L_2$
S = Severity = Q + T + A
Risk = L + S
Overall Risk = Maximum Risk

Risk Level	Overall Risk
Low	Less than -4
Medium	Between -4 and 0
High	Greater than 0

COMPLETED SHEETS FROM TASK V:

BLOCK III OF THE MASTER SCORESHEET AND THE RISK MATRIX

Master Scoresheet

BLOCK I		
TASK 2: IDENTIFY SOURCES		
#	Category	Name
1	SEPTIC SYSTEMS	GROUP OF SEPTIC SYSTEMS
2	TANKS	WIDGETS-R-US

BLOCK II						
CONTAMINANT/ MIXTURE	CARCINOGEN/ NON-CARCINOGEN	TASK 3 SOURCE ELEMENTS			TASK 4 TRANSPORT ELEMENTS	
		L_1	Q	T	L_2	A
NITRATES	NON-CARCIN.	0	4.3	-1.5	0	-4.6
CHLOROFORM	CARCIN	-2.3	1.5	1.2	0	-3
1,1,1-TCA	NON-CARCIN		2	-0.5	-0.1	-1.5

BLOCK III					
TASK 5: ESTIMATE RISKS AND RANK SOURCES					
L	S	Risk	Overall Risk	Rank	Risk Level
0	-1.8	-1.8	-1.8	1	M
-2.3	-0.3	-2.6	-2.4	2	M
-2.4	0	-2.4			

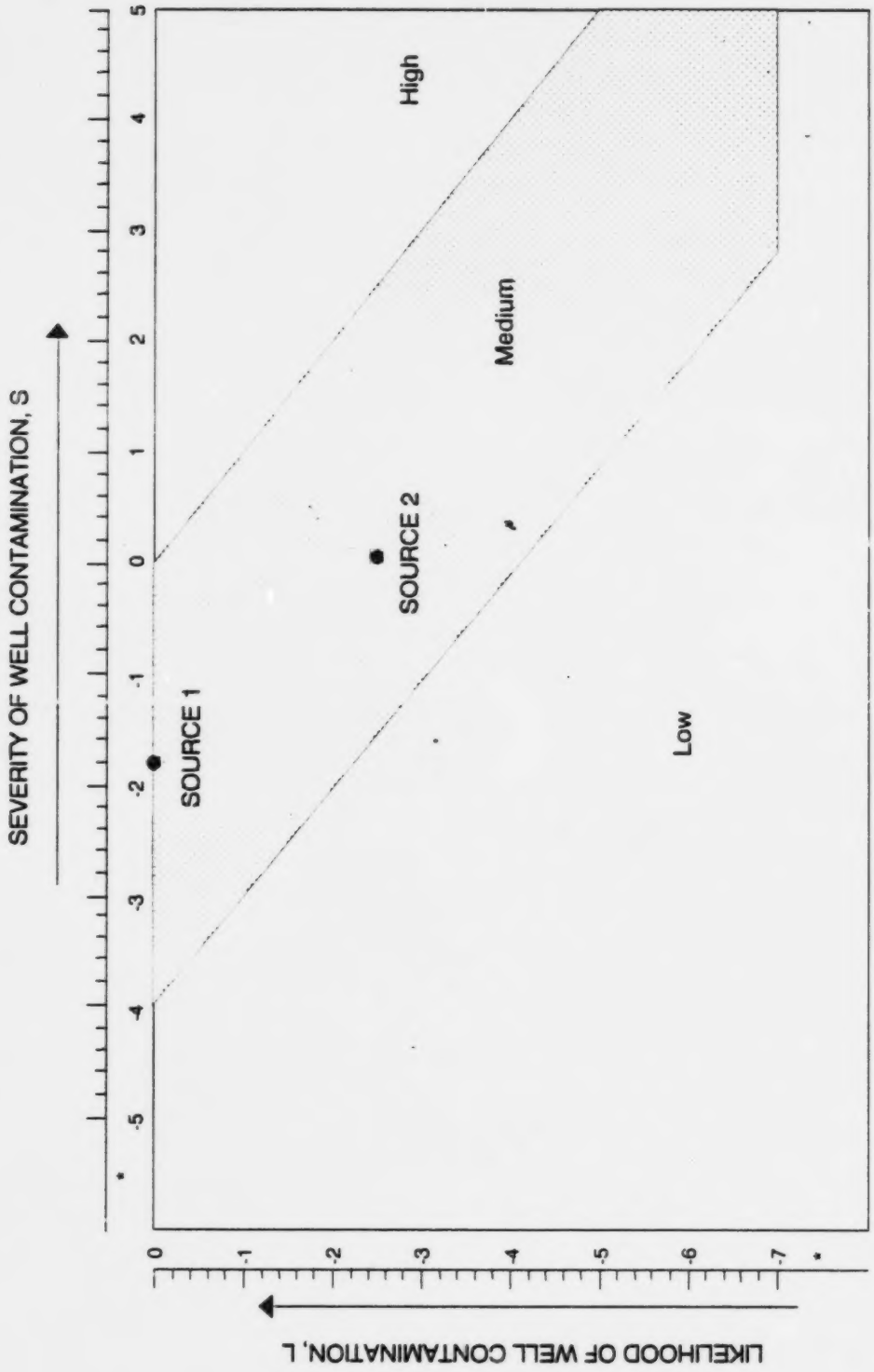
L_1 = Likelihood of Release
Q = Quantity of Contaminant Released
T = Toxicity of Contaminant

L_2 = Likelihood of Reaching the Well
A = Attenuation Due to Transport

L = Likelihood = $L_1 + L_2$
S = Severity = Q + T + A
Risk = L + S
Overall Risk = Maximum Risk

Risk Level	Overall Risk
Low	Less than -4
Medium	Between -4 and 0
High	Greater than 0

Risk Matrix


SEVERITY OF WELL CONTAMINATION, S
-5
-4
-3
-2
-1
0
1
2
3
4
5
SOURCE 1
SOURCE 2
High
Medium
Low
0
-1
-2
-3
-4
-5
-6
-7
LIKELIHOOD OF WELL CONTAMINATION, L

CHAPTER 3: MASTER SCORESHEET, WELLHEAD DATASHEET, RISK MATRIX, AND CONTAMINANT FORMS

MASTER SCORESHEET

Master Scoresheet

BLOCK I		
TASK 2: IDENTIFY SOURCES		
#	Category	Name

BLOCK II						
CONTAMINANT/ MIXTURE	CARCINOGEN/ NON-CARCINOGEN	TASK 3: SOURCE ELEMENTS			TASK 4: TRANSPORT ELEMENTS	
		L_1	Q	T	L_2	A

BLOCK III					
TASK 5: ESTIMATE RISKS AND RANK SOURCES					
L	S	Risk	Overall Risk	Rank	Risk Level

L_1 = Likelihood of Release
Q = Quantity of Contaminant Released
T = Toxicity of Contaminant

L_2 = Likelihood of Reaching the Well
A = Attenuation Due to Transport

L = Likelihood = $L_1 + L_2$
S = Severity = Q + T + A
Risk = L + S
Overall Risk = Maximum Risk

Risk Level	Overall Risk
Low	Less than -4
Medium	Between -4 and 0
High	Greater than 0

WELLHEAD DATASHEET

Step 2

Author: _____

WELLHEAD DATASHEET Date: _____

PARAMETER	INSTRUCTIONS	SCORE
WD1 Planning Period	Enter the number of years over which you are concerned with the possibility of contamination of the well. Other things being equal, the longer the planning period, the higher the likelihood that contaminants released at the source will reach the well within the Planning Period considered.	_____
WD2 Depth to Aquifer Score	Use **Table W.1** to convert the depth to the aquifer in the wellhead protection area (WHPA) into a Depth to Aquifer Score. For example, if the depth to the aquifer is between 50 feet and 150 feet, then the Depth to Aquifer Score is equal to 1.5. **Note:** If you have a confined aquifer, please refer to Setting 4 in Technical Appendix A under the heading "Aquifer Physical Properties."	_____
WD3 Aquifer Thickness Score	Use **Table W.1** to convert the thickness of the aquifer in the WHPA into an Aquifer Thickness Score. For example, if the aquifer thickness is between 3.6 meters and 1.5 meters, then the Aquifer Thickness Score is equal to 1.0. Note that you are using the same table for determining the Depth to Aquifer Score and the Aquifer Thickness Score.	_____
WD4 Net Infiltration	Enter the annual net infiltration in inches for the WHPA. If this is not known, use the net infiltration map (**Figure W.1**) to determine the Net Infiltration given the geographic location of the WHPA. For example, if the WHPA is in New York State, then the Net Infiltration is equal to 20.	_____

Table W.1

Depth to Aquifer or Aquifer Thickness	(m)	0-3.6	3.6-15	15-45	45-260
	(ft)	0-12	12-50	50-150	150-850
Depth to Aquifer Score or Aquifer Thickness Score		0.3	1.0	1.5	2.2

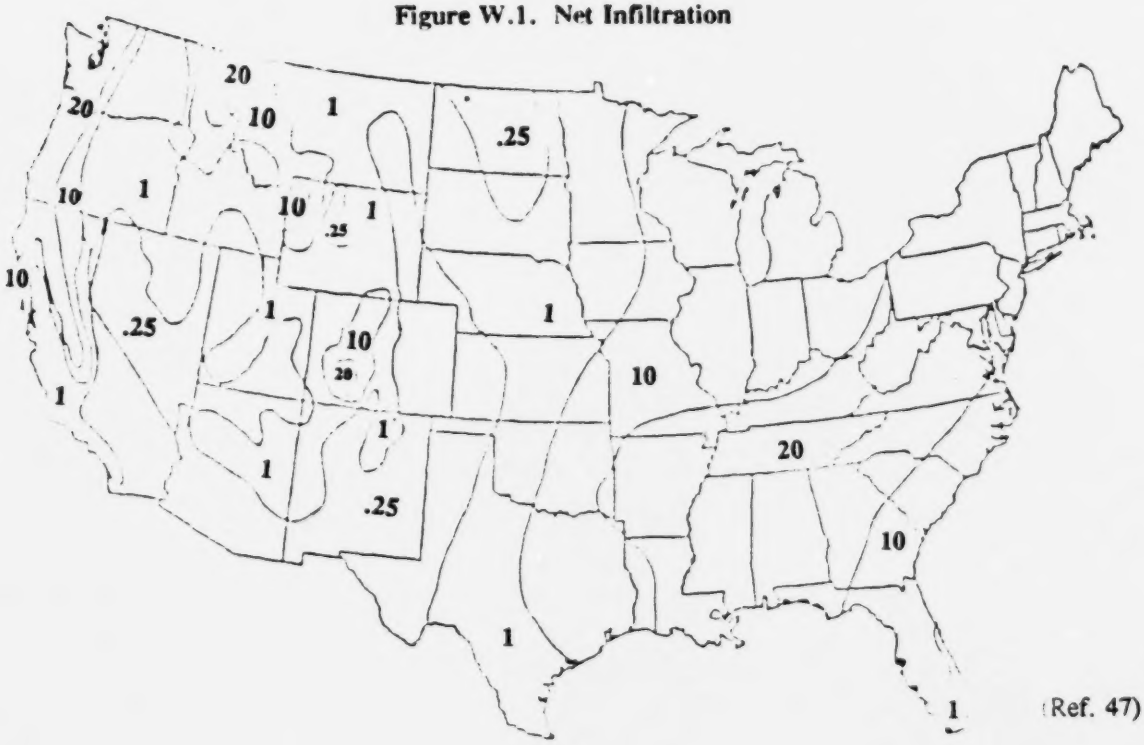
Table W.2

Hydraulic Conductivity (cm/s)	10^{-9} - 10^{-7}	10^{-7} - 10^{-5}	10^{-5} - 10^{-3}	10^{-3} - 10^{-1}	10^{-1} - 10^{1}
Unsaturated Zone Hydraulic Conductivity Score	1	2	3	4	5

Table W.3

Unsaturated Zone Material	Clay	Clayey-Silt or Silt	Silty-Sand or Sand	Sandy-Gravel or Gravel	Karst
Unsaturated Zone Hydraulic Conductivity Score	1	2	3	4	5

Figure W.1. Net Infiltration



(Ref. 47)

WELLHEAD DATASHEET (continued)

PARAMETER	INSTRUCTIONS	SCORE
WD5 Unsaturated Zone Hydraulic Score	**If you know** the hydraulic conductivity of the unsaturated zone, then use **Table W.2** to determine the Unsaturated Zone Conductivity Score. For example, if the conductivity of the unsaturated zone is between 10^{-7} centimeters/second and 10^{-5} centimeters/second, then the Unsaturated Zone Conductivity Score is equal to 2. **If you do not know** the conductivity of the Unsaturated zone, then use **Table W.3** to determine the Unsaturated Zone Hydraulic Score as a function of the type of material in the unsaturated zone. For example, if the type of material in the unsaturated zone is sand, then the Unsaturated Zone Hydraulic Conductivity Score is equal to 3.	_____
WD6 Saturated Zone Material	Either Silt, Sand, Gravel, or Karst as the Saturated Zone Material. Note that the Saturated Zone Material cannot be Clay.	_____
WD7 Ground-Water Velocity Score	**If you know** the average ground-water velocity in the WHPA that takes into account the effects of pumping, then use **Table W.4** to determine the Ground-Water Velocity Score. For example, if the average ground-water velocity in the WHPA is between 10 meters/year and 10^3 meters/year, then the Ground-Water Velocity Score is equal to 3. **If you do not know** the ground-water velocity in the WHPA, then use **Table W.5** to determine the Ground-Water Velocity Score as a function of the type of material in the saturated zone. For example, if the type of material in the saturated zone is Gravel, then the Ground-Water Velocity Score is equal to 5. **Note** that if the Saturated Zone Material is Sand, then the Ground-Water Velocity Score depends on the pumping rate at the Wellhead. If the Saturated Zone material is Sand and the pumping rate is less than 45 million gallons/day	_____

WELLHEAD DATASHEET (continued)

PARAMETER	INSTRUCTIONS	SCORE
	(30,000 gallons/minute), then the Ground-Water Velocity Score is equal to 3. If the Saturated Zone material is Sand and the pumping rate at the wellhead is greater than or equal to 45 million gallons/day (30,000 gallons/minute), then the Ground-Water Velocity Score is equal to 4.	

Table W.4

Ground-Water Velocity	(m/yr)		10^{-1} - 10^{1}	10^{1} - 10^{3}	10^{3} - 10^{5}	10^{5} - 10^{7}
	(ft/yr)		0.3 - 3.3	3.3×10^{1} - 3.3×10^{3}	3.3×10^{3} - 3.3×10^{5}	3.3×10^{5} - 3.3×10^{7}
Ground-Water Velocity Score			2	3	4	5

Table W.5

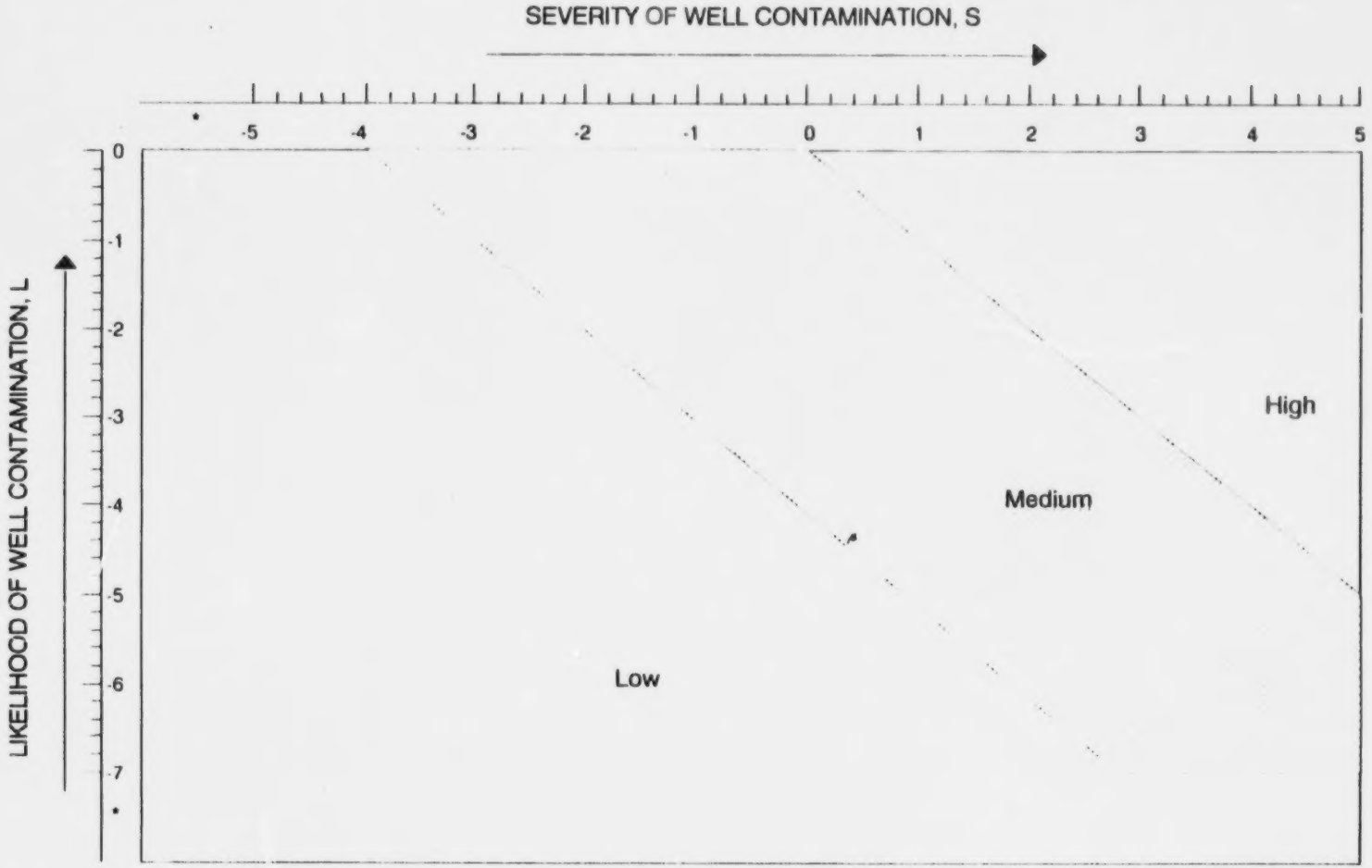
Saturated Zone Material		Silt	Sand	Gravel	Karst
Ground-Water Velocity Score		2	3 or 4*	5	5

* 3 if the wellhead pumping rate is less than 45 million gallons/day

4 if the wellhead pumping rate is greater than or equal to 45 million gallons/day

RISK MATRIX

Risk Matrix


SEVERITY OF WELL CONTAMINATION, S
-5
-4
-3
-2
-1
0
1
2
3
4
5
LIKELIHOOD OF WELL CONTAMINATION, L
0
-1
-2
-3
-4
-5
-6
-7
High
Medium
Low

CONTAMINANT FORMS

CONTAMINANT FORMS

USING THE CONTAMINANT FORMS

The contaminant forms (S.1 and S.2) provide contaminant-specific scores necessary to complete the contaminant data tables contained in all of the Source Datasheets (see Chapter 2, Step 5 Guidance). These forms help you determine the Toxicity, Mobility, Persistence, and Concentration scores for each contaminant or contaminant mixture present at a given source. You should use Form S.1 if you know what contaminants are present at a source and the concentration of each contaminant. Otherwise, you need to use Form S.2, which provides default values.

Form S.1

You should use Form S.1 if you already know both the contaminants present at a particular source and the concentration of those contaminants. Form S.1 contains one table and one graph. The table provides the following information for each contaminant:

- contaminant name
- "type" of contaminant
- Toxicity, Mobility, and Persistence scores
- references for these scores.

The graph will help you determine the Concentration score for each contaminant as a function of the contaminant's concentration at a given source.

Contaminant Name

Under the column titled "Contaminant," the table in Form S.1 lists in alphabetical order over 60 potential ground-water contaminants. To use this table, find each contaminant present at a source and copy its name onto the contaminant data table in the Source Datasheet. If Form S.1 lists some, but not all of the contaminants that you know are present at a given source, supplement the information from Form S.1 with default values from Form S.2. If Form S.1 does not list any of the contaminants that you know are present at a given source, then you must use Form S.2 to obtain default values.

Type of Contaminant

Under the column titled "Type," the table in Form S.1 indicates whether a particular contaminant is (1) a carcinogen or a non-carcinogen, and (2) a potential dense non-aqueous phase liquid (DNAPL), also known as a sinker, or a potential light non-aqueous phase liquid (LNAPL), also known as a floater. If a contaminant is a potential DNAPL (or a potential LNAPL, respectively) and the quantity that is released annually is very high, the contaminant will behave like a DNAPL (or LNAPL, respectively) and the final risk score may over-estimate or under-estimate the risk to the wellhead. This is because it is assumed here that all contaminants are dissolved in the water, whereas DNAPLs or LNAPLs do not dissolve as readily and may migrate vertically. If the Quantity score for a potential DNAPL or LNAPL is greater than or equal to 3, then the contaminant is a true DNAPL or LNAPL, and the Risk score for that contaminant could be over-estimated or under-estimated (see Chapter 2, Steps 5 and 6, and Technical Appendix A).

Toxicity

The Toxicity score for each contaminant is presented as a real number. Copy the corresponding Toxicity score for each contaminant present at a given source onto the contaminant data table in the Source Datasheet.

Mobility

The Mobility score for each contaminant is presented as either an "L" for low mobility, "M" for medium mobility, or "H" for high mobility. Copy the corresponding Mobility score for each contaminant present at a given source onto the contaminant data table. The Mobility score is based on the retardation factor of each contaminant. The retardation factor is a unitless factor defined as the ratio of the ground-water velocity to the contaminant velocity in the saturated zone.

Persistence

Like the Mobility score, the Persistence score for each contaminant is expressed as either an "L," "M," or "H." Copy the corresponding Persistence score for each contaminant present at a given source onto the contaminant data table. The Persistence score is based on the degradation rate of each contaminant. The degradation rate is the annual exponential rate of decomposition of the contaminant due to chemical breakdown by bacterial action and other environmental factors.

Contaminant Concentration Scoring Graph

The Contaminant Concentration Scoring Graph provided at the end of Form S.1 allows you to determine the Concentration score for each contaminant present at a given source. To obtain the Concentration score for a contaminant present in any source category except Agrichemical Application, you need to know the concentration of the contaminant at the source (in milligrams per liter (mg/l) or parts per million (ppm); 1 mg/l = 1 ppm). To use the Contaminant Concentration Scoring Graph, find the concentration of the contaminant on the horizontal axis, which uses a decimal logarithmic scale. Read up from this concentration until you hit the solid diagonal line. Mark that point on the solid diagonal line. Next, find the Concentration score on the vertical axis that corresponds to the point you marked on the solid diagonal line. Copy that Concentration score onto the contaminant data table. For example, if you know the concentration of a contaminant is 0.3 mg/l, then the Concentration score for that contaminant is approximately -3.5.

To obtain a Concentration score for a contaminant used in Agrichemical Applications, first obtain the application rate of the contaminant expressed in units of kilograms per hectare per year (kg/hectares/yr). Then, following the instructions above but replacing kg/hectare/yr for mg/l, find the corresponding Concentration score from the vertical axis of the scoring graph. Next add 3 to that score to arrive at the final Concentration score. For example, if a farmer applies the pesticide Dicamba at a rate of 40 kg/hectare/yr, then the final Concentration score for Dicamba is approximately -1.2 + 3, or 1.8. See the hypothetical example in Chapter 2 for another illustration of how to use the scoring graph.

Form S.2

You need to use Form S.2 to complete the contaminant data table for a given source (1) if you do not know the contaminants present at that source and their concentrations, or (2) if you know the contaminants, but they are not listed in Form S.1. Form S.2 contains default Toxicity, Concentration, Mobility, and Persistence scores for selected default contaminants and contaminant mixtures for each source category. Form S.2 is organized by source categories and within each category by different types of sources. For example, the source category for surface impoundments (Exhibit 5 in Chapter 2) lists different types of surface impoundments including hazardous waste (Subtitle C) impoundments, non-hazardous waste impoundments, ponds, and lagoons.

To use Form S.2, find the correct source category for your source (see Chapter 2, Step 4 Guidance). The source categories are noted in the heading of each page of Form S.2; they are arranged alphabetically, with each source category starting on a new page. Form S.2 also lists different types of sources that fall within a given source category.

After you find the correct source category and type of source within that category, copy the default Toxicity, Concentration, Mobility, and Persistence scores for the default contaminants listed onto the contaminant data table in the Source Datasheet. You may decide, however, not to include one or more of the default contaminants in the contaminant data table. For example, you may know that a particular default contaminant listed is not present at your source; therefore, you may decide not to list that contaminant in the contaminant data table.

To illustrate how to use Form S.2, assume you have identified the on-site waste disposal operations at a service station within your WHPA as a potential source of contamination, but you do not know what contaminants the station's personnel dispose. Using the guidance provided in Step 4 (Chapter 2), you determine that the appropriate source category for this source is Injection Wells: Shallow Wells (Class V). To determine default contaminants for this source, you need to find this source category in Form S.2. You then read down the first column to find the most appropriate type of source that corresponds to your source. You determine the Automobile Service Station Disposal Wells -- Service and Repair best matches your source. The default contaminants for this source are Arsenic, Chromium, and a Metals Mix. You thus copy these contaminant names and their corresponding default Toxicity, Concentration, Mobility, and Persistence scores onto the contaminant data table in the Source Datasheet for that source.

Form S.1
Toxicity, Mobility and Persistence Scores by Contaminant

Contaminant	Type[a]	Toxicity		Mobility		Persistence	
		Score[b]	Reference[c]	Score[d]	Reference[e]	Score[f]	Reference[g]
1,1,1-Trichloroethane	N, D	-0.5	IRIS	M	31	M	47,27
1,1,2,2-Tetrachloroethane	C, D	2.8	IRIS	M	31	L	47
1,2-Dichlorobenzene	N, D	-0.5	HEAST	M	31	L	47,27
1,2-Trans-Dichloroethylene	N, D	0.2	IRIS	H	31	L	27
2,4,5-TP Silvex	C	2.1	IRIS	M	47	M	66
2,4,6-Trichlorophenol	C, D	1.8	IRIS	M	47	M	59
2,4-D	N	0.5	IRIS	M	37	L	37
Acetic Acid	N	-1.5	IRIS	H	BEJ	L	BEJ
Acetone	N	-0.5	IRIS	H	31	L	BEJ
Alachlor	N	0.5	IRIS	M	BEJ	M	BEJ
Aldicarb	N	1.3	IRIS	H	31	M	47
Antimony	N	1.9	IRIS	L	31	H	47
Arsenic	C	3.7	HEAST	H	47	H	47
Atrazine	N	0.8	IRIS	M	31	M	37
Barium	N	-0.3	IRIS	H	31	H	47
Bentazon	N	1.1	IRIS	M	BEJ	M	BEJ
Benzene	C, L	2.0	IRIS	M	31	L	27
Beryllium	N	0.8	IRIS	M	BEJ	M	BEJ
Bis(2-ethylhexyl)phthalate	C, D	1.5	IRIS	L	31	H	47
Boron	N	-0.5	HEAST	M	BEJ	H	47
Butylate	N, L	-0.3	IRIS	M	47	M	BEJ
Cadmium	N	1.7	HEAST	M	31	H	47
Carbon Tetrachloride	C, D	2.5	IRIS	M	31	L	47,27
Chloride	N	-2.4	MCL	H	31	H	BEJ
Chloroform	C	1.2	IRIS	H	31	M	27

Form S.1
Toxicity, Mobility and Persistence Scores by Contaminant

Contaminant	Type[a]	Toxicity		Mobility		Persistence	
		Score[b]	Reference[c]	Score[d]	Reference[c]	Score[f]	Reference[c]
Chromium	N	0.7	IRIS	H	31	H	47
Cresol	N	-0.2	IRIS	L	47	M	BEJ
Cyanazine	N	1.2	IRIS	M	BEJ	M	BEJ
Cyanide	N	0.2	IRIS	H	31	M	47
Dicamba	N	0.0	IRIS	M	37	L	37
Dichloroethane	C, D	2.4	IRIS	H	31	L	47,27
Dichloromethane	C, D	1.3	IRIS	H	31	L	47,27
Dinitro-butyl phthalate	N, D	-0.5	HEAST	M	BEJ	L	BEJ
Endrin	N	2.5	IRIS	L	BEJ	M	BEJ
EPTC +	N, L	0.1	IRIS	M	47	M	37
Ethylbenzene	N, L	-0.5	IRIS	M	31	L	47
Hexachlorobenzene	C, D	3.7	IRIS***	M	47	M	47,59
Hexachlorobutadiene	C, D	2.3	IRIS	L	47	L	27
Hexachlorocyclopentadiene	N, D	0.6	IRIS	M	47	M	31
Iron	N	0.5	MCL	M	BEJ	H	47
Lead	N	1.3	MCL	M	31	H	47
Lindane	C	3.6	HEAST	M	47	L	47
Manganese	N	-0.8	HEAST	H	BEJ	H	47
Mercury	N, D	2.0	HEAST	M	31	H	47
Methanol	N	-1.2	IRIS	H	31	H	47
Methyl ethylketone	N, L	-0.2	IRIS	H	31	L	27
Methoxychlor	N	2.3	IRIS	L	47	M	BEJ
Metolachor	N	-0.5	IRIS	M	31	M	31
Metribuzin	N	0.1	IRIS	M	BEJ	M	BEJ
M-xylene	N, L	-0.8	IRIS	M	31	L	BEJ

Form S.1
Toxicity, Mobility and Persistence Scores by Contaminant

Contaminant	Type[a]	Toxicity		Mobility		Persistence	
		Score[b]	Reference[c]	Score[d]	Reference[e]	Score[f]	Reference[g]
Naphthalene	N, D	-1.1	HEAST	M	31	L	BEJ
Nickel	N	0.2	IRIS	M	47	H	47
Nitrate-Nitrogen	N	-1.5	IRIS	H	31	M	31
Nitrobenzene	N, D	1.8	IRIS	H	31	L	27
Phenol	N	-1.3	IRIS	H	31	L	27
Selenium	N	1.0	HEAST	H	BEJ	H	BEJ
Silver	N	1.0	IRIS	M	BEJ	H	47
Sulfuric Acid	N	-1.2	MCL	H	BEJ	H	BEJ
Tetrachloroethylene	N, D	0.5	IRIS	M	31	M	47
Trichlorethylene	C, D	1.5	HEAST	M	47	M	47
Tin	N	-1.3	HEAST	M	BEJ	H	47
Toluene	N, L	-1.0	IRIS	M	31	L	27
Trifluralin	C	1.3	IRIS	L	39	M	39
Vandium	N	1.5	IRIS	M	31	H	27
Vinyl chloride	C, L	3.8	HEAST	H	31	L	27
Xylene	N, L	-0.8	IRIS	M	31	L	BEJ
Zinc	N	-0.8	HEAST	M	31	H	47

Form S.1
Key to Notes

a
C = Carcinogen
N = Non Carcinogen
D = Dense Non-Aqueous Phase Liquid
L = Light Non-Aqueous Phase Liquid

b **Toxicity score (T)** is the Logorithm of the inverse of the Critical Concentration (CC).

$$T = \log\left(\frac{1}{cc}\right)$$

For carcinogens, CC is defined as the contaminant concentration in drinking water equivalent to a 10^{-6} individual health risk (assuming 70 kg body weight and 2l/d average water consumption):

$$cc\ (mg/l) = \frac{1 * 10^{-5} * 70\ kg}{q_1^*(mg/kg/d)^{-1} * 2\ l/d}$$

where q^* is the carcinogenic potency factor.

For non-carcinogens, the critical concentration is equal to the oral reference dose.

c
IRIS Integrated Risk Information System, Office of Research and Developement, U.S. EPA. IRIS is EPA's authoritative interpretation of chemical health effects data.

HEAST Health Effects Assessment Summary Tables, ORD RD-689, April 1989. Office of Research and Development/Office of Emergency and Remedial Response, U.S. EPA. HEAST references are used for contaminants not listed in IRIS.

MCL Maximum Contaminant Level, National Drinking Water Standard.

d **Mobility score** is based on the "Retardation Factor," as follows:
Low Retardation Factor greater than 1,000
Medium Retardation Factor between 10 and 1,000
High Retardation Factor less than 10

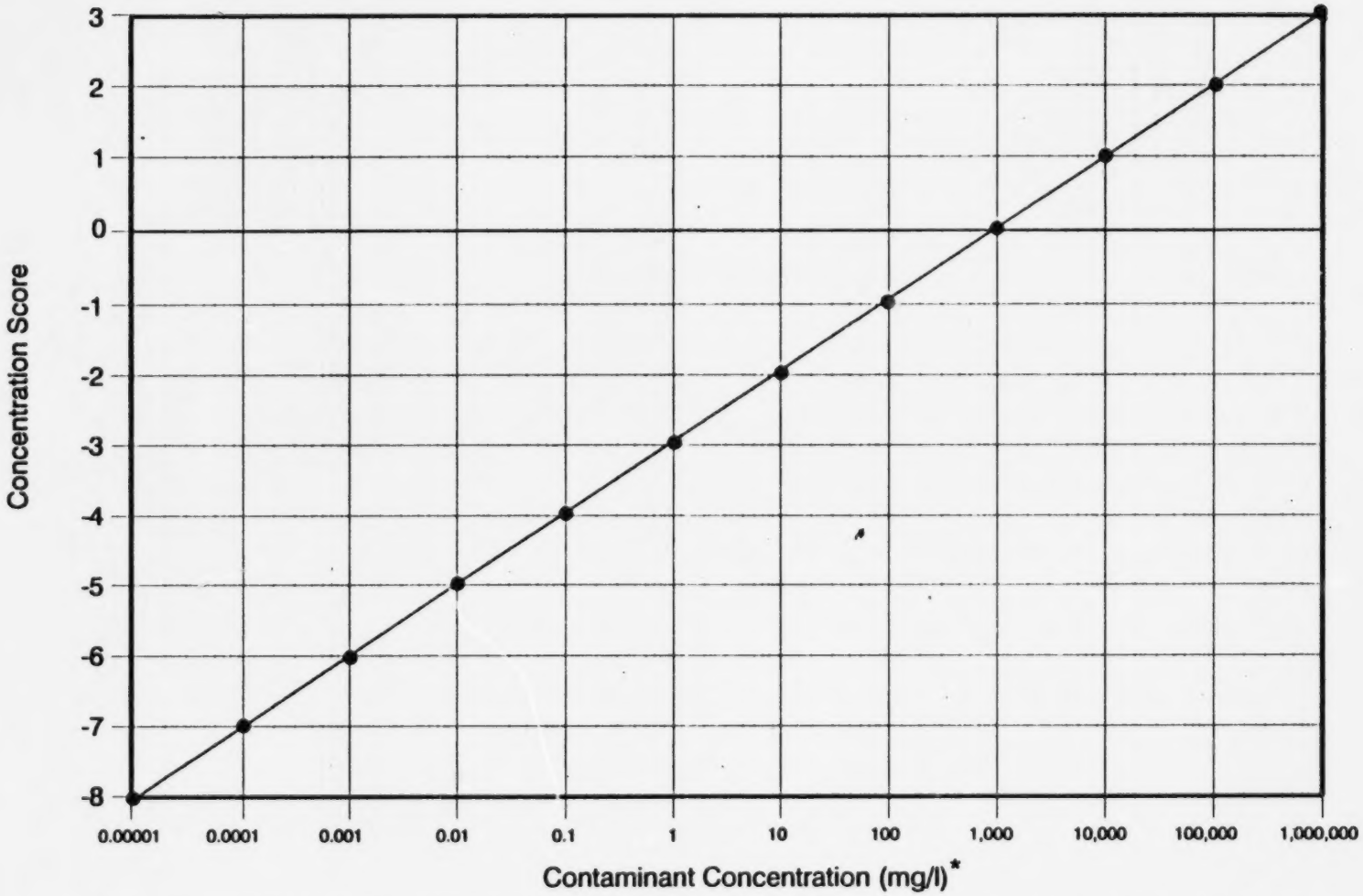
e **Reference** refers to citations listed in the Bibliography at the end of this manual

f **Persistence score** is based on the "Degradation Rate" as follows:
Low Degradation Rate greater than 19/yr.
Medium Degradation Rate between 0.0069/yr and 19/yr.
High Degradation Rate less than 0.0069/yr.

g **BEJ** Best Engineering Judgment

*** This entry has been approved; IRIS input is pending (HEAST document).

CONTAMINANT CONCENTRATION SCORING GRAPH



* Units of concentration are mg/l for all contaminants except Agrichemical Application contaminants. Units for Agricultural Application contaminants are expressed as an application rate in kg/hectare/year.

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Agrichemical Application

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
Corn Crop - Pesticides					
Non-carcinogens:	dicamba	0.0	-1.2	H	M
	other pesticides	-0.1	0.6	M	M
Corn Crop - Fertilizers					
Non-carcinogens:	nitrate-nitrogen	-1.5	1.5	H	M
Soybean Crop - Pesticides					
Carcinogens:	trifluralin	1.3	-0.6	L	M
Non-carcinogens:	other pesticides	-0.2	0.1	M	M
Soybean Crop - Fertilizers					
Non-carcinogens:	nitrate-nitrogen	-1.5	-0.2	H	M
Cotton Crop - Pesticides					
Non-carcinogens:	aldicarb[1]	1.3	0.3	H	M
	aldicarb[2]	1.3	-0.6	H	M
Cotton Crop - Fertilizers					
Non-carcinogens:	nitrate-nitrogen	-1.5	1.1	H	M
Wheat Crop - Pesticides					
Non-carcinogens:	aldicarb[1]	1.3	0.3	H	M
	aldicarb[2]	1.3	-0.6	H	M
Wheat Crop - Fertilizers					
Non-carcinogens:	nitrate-nitrogen	-1.5	0.9	H	L
Other Crops - Pesticides					
Non-carcinogens:	aldicarb[1]	1.3	0.3	H	M
	aldicarb[2]	1.3	-0.6	H	M

NOTES:
[1] High irrigation, any soil type
[2] Medium irrigation, loamy sandy soil, or sandier

REFERENCES:
Pesticides: 9, 31, 32, 49, 70
Fertilizers: 1, 6, 26

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Container Storage and Material Transfer

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
HAZARDOUS WASTE/ACCUMULATION					
D001: Ignitable Wastes					
Carcinogens:	benzene	2.0	2.1	M	L
Non-carcinogens:	methanol	-1.2	2.0	H	H
	organics mix[1]	-0.4	2.5	H	L
D002: Corrosive Wastes					
Non-carcinogens:	methanol	-1.2	1.6	H	H
	toluene	-1.0	1.6	M	L
F001: Spent, Halogenated Solvents Used For Degreasing					
Carcinogens:	chloroform	1.2	2.0	H	M
	carbon tetrachloride	2.5	2.0	M	M
Non-carcinogens:	organics mix[2]	-0.3	2.5	M	L
F003: Spent, Non-Halogenated Solvents					
Carcinogens:	benzene	2.0	2.0	M	L
Non-carcinogens:	methyl ethyl ketone	-0.2	2.0	H	L
RCRA PERMITTED STORAGE					
D001: Ignitable Wastes					
Carcinogens:	benzene	2.0	2.1	M	L
Non-carcinogens:	methanol	-1.2	2.0	H	H
	organics mix[1]	-0.4	2.5	H	L
F003: Spent, Non-Halogenated Solvents					
Carcinogens:	benzene	2.0	2.0	M	L
Non-carcinogens:	methyl ethyl ketone	-0.2	2.0	H	L
X500: Ignitable Waste Mixtures					
Carcinogens:	benzene	2.0	2.0	M	L
Non-carcinogens:	organics mix[1]	-0.4	2.4	H	L

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Container Storage and Material Transfer

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
X501: Corrosive Waste Mixtures					
Non-carcinogens:	chromium mix[3]	-1.2	1.6	H	H
	lead	1.3	-1.0	M	H
X504: Toxic Waste Mixtures					
Carcinogens:	chloroform	1.2	2.0	H	M
	carbon tetrachloride	2.5	2.0	M	L
Non-carcinogens:	organics mix[4]	-0.2	2.3	M	M
HAZARDOUS MATERIALS/PRODUCTS					
Petroleum (gasoline)					
Carcinogens:	benzene	2.0	-2.7	M	L
Petroleum (diesel)					
Carcinogens:	benzene	2.0	-2.7	M	L
Chemical/Cleaning Liquids (corrosive)					
Non-carcinogens:	acetic acid	-1.5	2.4	H	L
Sulfuric Acid					
Non-carcinogens:	sulfuric acid	-1.2	3.3	H	H
Paint Dryer (flammable)					
Carcinogens:	benzene	2.0	2.9	M	L
Non-carcinogens:	organics mix 1[6]	-0.2	3.2	H	L
	organics mix 2	-0.4	3.3	M	L

NOTES:

1. acetone and methylethyl ketone
2. 1,2-dichlorobenzene
3. chromium and methanol
4. 1,1,1-trichloroethane
5. methyl ethyl ketone, cresol and acetone
6. xylene, napthalene, toluene and 1,1,1-trichloroethane

REFERENCES:

Hazardous Waste Treatment, Hazardous Waste Storage: 25

Product Storage:

Petroleum: 12

Chemical: 25, 40

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Injection Wells/Deep Wells (Classes I, II, and III)

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
Class I: Wastewater Disposal					
Carcinogens:	benzene	2.0	-1.8	M	L
Non-carcinogens:	chromium mix[1]	-1.2	1.6	H	H
	cyanide	0.2	-0.4	H	L
Class II: Oil and Gas Activity					
Carcinogens:	arsenic	3.7	-4.7	H	H
	benzene	2.0	-3.3	M	L
Non-carcinogens:	boron	-0.5	-2.0	M	H
Class III: Mineral Extraction - Metals Mining					
Carcinogens:	arsenic	3.7	-2.6	H	H
Non-carcinogens:	metals mix 1[2]	-0.8	-0.3	H	H
	metals mix 2[3]	0.3	0.3	M	H

NOTES:

[1] chromium and sulfuric acid
[2] chromium, manganese and barium
[3] nickel, vanadium, mercury, iron, cadmium, zinc, berylium, silver and lead

REFERENCES:

Class I: 54
Class II: 63
Class III: 9

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Injection Wells/Shallow Wells (Class V)

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
Medium Throughput (between 2.6 and 31.2 million gallons/year)					
Inorganic Chemical Manufacture					
Non-carcinogens:	chromium	0.7	-4.0	H	H
	cyanide	0.1	-3.7	H	M
	metals mix[4]	-0.4	-2.1	M	H
Laundry and Cleaning Services					
Non-carcinogens:	tetrachloroethylen e	0.5	-1.3	M	M
High Throughput (more than 31.2 million gallons/year)					
Electroplating					
Non-carcinogens:	chromium	0.7	-4.0	H	H
	cyanide	0.1	-3.7	H	M
	metals mix[5]	-0.3	-2.0	M	H
Cooling waters					
Non-carcinogens:	chromium	0.7	-3.7	H	H

NOTES:

1. cadmium and lead
2. cyanide, phenol and acetone
3. iron, boron and silver
4. nickel, mercury, zinc and lead
5. nickel, zinc, iron, silver, cadmium and lead

REFERENCES:

Agricultural Drainage Wells:
- Pesticides: 70, 49
- Fertilizers 70, 9

Automobile Service Station Disposal Wells:
- Service and repair, body shops, and car washing: 14

Industrial Process Water Disposal Wells:
- Low throughput: 25, 52
- Medium throughput: 25, 50
- High throughput: 25, 51, 53

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Injection Wells/Shallow Wells (Class V)

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
AGRICULTURAL DRAINAGE WELLS					
Corn Crop					
Non-carcinogens:	dicamba	0.0	-4.9	H	M
	other pesticides	-0.1	-3.1	M	M
	nitrate-nitrogen	-1.5	-2.2	H	M
Soybean Crop					
Carcinogens:	trifluralin	1.3	-4.3	L	M
Non-carcinogens:	other pesticides	-0.2	-3.6	M	M
	nitrate-nitrogen	-1.5	-4.3	H	M
Other Crops					
Non-carcinogens:	aldicarb	1.3	-3.6	H	M
	nitrate-nitrogen	-1.5	-2.6	H	M
AUTOMOBILE SERVICE STATION DISPOSAL WELLS					
Service and Repair					
Carcinogens:	arsenic	3.7	-4.0	H	H
Non-carcinogens:	chromium	0.7	-3.4	H	H
	metals mix[1]	1.3	-1.5	M	H
Body Shops					
Non-carcinogens:	chromium	0.7	-1.6	H	H
	metals mix[1]	1.5	-2.8	M	H
Car Washing					
Carcinogens:	arsenic	3.7	-4.9	H	H
Non-carcinogens:	chromium	0.7	-4.8	H	H
	metals mix[1]	1.3	-4.0	M	H
INDUSTRIAL PROCESS WATER DISPOSAL WELLS					
Low Throughput (less than 2.6 million gallons/year)					
Non-carcinogens:	methanol	-1.2	-2.9	H	H
	cyanide mix[2]	-1.0	-2.6	H	L
	metals mix[3]	-0.2	-2.5	M	H

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Land Treatment

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
Petroleum Refining:					
Carcinogens:	arsenic	3.7	-1.5	H	H
	benzene	2.0	-0.9	M	L
Non-carcinogens:	metals mix 1[1]	0.4	-0.6	H	H
	metals mix 2[2]	0.8	-0.6	M	H
Inorganic Chemicals:					
Non-carcinogens:	chromium (total)	0.8	-0.9	H	H
	metals mix[3]	-0.5	-2.0	M	H
Organic Chemicals:					
Non-carcinogens:	chromium (total)	0.8	-1.8	H	H
	metals mix[4]	0.0	-1.6	M	H

NOTES:

[1] chromium and barium
[2] lead, vanadium, nickel and zinc
[3] chromium, zinc and nickel
[4] lead, zinc and cadmium

REFERENCES:

Petroleum refining, inorganic chemicals, and organic chemicals: 22, 23

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Landfills

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
Hazardous Waste ("Subtitle C" Sites) and Municipal Waste ("Subtitle D" Sites) pre-1976					
Carcinogens:	arsenic	3.7	-2.6	H	H
	benzene	2.0	-2.4	M	L
Non-carcinogens:	chromium	0.7	-2.0	H	H
Municipal Waste ("Subtitle D" Sites) post-1976					
Carcinogens:	arsenic	3.7	-5.0	H	H
	organics mix[1]	3.4	-3.5	H	L
Non-carcinogens:	iron	0.5	-1.2	M	H

NOTES:

[1] vinyl chloride and dichloromethane

REFERENCES:

Hazardous Waste/Municipal Waste (pre-1976): 21, 60
Municipal Waste: 42

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Material Transport

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
HAZARDOUS WASTE TREATMENT					
D001: Ignitable Wastes					
Carcinogens:	benzene	2.0	2.1	M	L
Non-carcinogens:	methanol	-1.2	2.0	H	H
	organics mix[1]	-0.4	2.5	H	L
D002: Corrosive Wastes					
Non-carcinogens:	methanol	-1.2	1.6	H	H
	toluene	-1.0	1.6	M	L
F001: Spent, Halogenated Solvents Used for Degreasing					
Carcinogens:	chloroform	1.2	2.0	H	M
	carbon tetrachloride	2.5	2.0	M	L
Non-carcinogens:	organics mix[2]	-0.3	2.5	M	M
F003: Spent, Non-Halogenated Solvents					
Carcinogens:	benzene	2.0	2.0	M	L
Non-carcinogens:	methyl ethyl ketone	-0.2	2.0	H	L
RCRA PERMITTED STORAGE					
D001: Ignitable Wastes					
Carcinogens:	benzene	2.0	2.1	M	L
Non-carcinogens:	methanol	-1.2	2.0	H	H
	organics mix[1]	-0.4	2.5	H	L
F003: Spent, Non-Halogenated Solvents					
Carcinogens:	benzene	2.0	2.0	M	L
Non-carcinogens:	methyl ethyl ketone	-0.2	2.0	H	L
X500: Ignitable Waste Mixtures					
Carcinogens:	benzene	2.0	2.0	M	L
Non-carcinogens:	organics mix[1]	-0.4	2.4	H	L

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Material Transport

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
X501: Corrosive Waste Mixtures					
Non-carcinogens:	chromium mix[3]	-1.2	1.6	H	H
	lead	1.3	-1.0	M	H
X504: Toxic Waste Mixtures					
Carcinogens:	chioroform	1.2	2.0	H	M
	carbon tetrachloride	2.5	2.0	M	L
Non-carcinogens:	organics mix[4]	-0.2	2.3	M	M
HAZARDOUS MATERIALS/PRODUCTS					
Petroleum (gasoline)					
Carcinogens:	benzene	2.0	-2.7	M	L
Petroleum (diesel)					
Carcinogens:	benzene	2.0	-2.7	M	L
Chemical/Cleaning Liquids (corrosive)					
Non-carcinogens:	acetic acid	-1.5	2.4	H	L
Sulfuric Acid					
Non-carcinogens:	sulfuric acid	-1.2	3.3	H	H
Paint Dryer (flammable)					
Carcinogens:	benzene	2.0	2.9	M	L
Non-carcinogens:	organics mix 1[5]	-0.2	3.2	H	L
	organics mix 2[6]	-0.4	3.3	M	L

NOTES:

[1] acetone and methyl ethyl ketone
[2] 1,2-dichlorobenzene
[3] chromium and methanol
[4] 1,1,1-trichloroethane
[5] methyl ethyl ketone, cresol and acetone
[6] xylene, napthalene, toluene and 1,1,1-trichloroethane

REFERENCES:

Hazardous Waste Treatment, Hazardous Waste Storage: 25
Product Storage:
Petroleum: 12
Chemical: 25, 40

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Pipelines

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
Sewer					
Carcinogens:	chloroform	1.2	-4.8	H	M
	benzene	2.0	-4.7	M	L
	bis(2-ethylhexyl)phthalate	1.5	-4.3	L	H
Non-carcinogens:	chromium	0.7	-3.8	H	H
Other (Includes Petroleum)					
Carcinogens	benzene	2.0	-2.3	M	L

REFERENCES:
Other: 69

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Septic Tank Systems

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
Septic Tank Systems					
Non-carcinogens:	nitrates	-1.5	-0.7	H	L

REFERENCES: 21

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Storage Piles

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
HEAP LEACHING PILES					
Carcinogens:	arsenic	3.7	-2.6	H	H
Non-carcinogens:	metals mix 1[1]	-0.8	-0.3	H	H
	metals mix 2[2]	0.3	0.3	M	H
NON-HEAP LEACHING PILES/HAZARDOUS WASTE PILES*					
D002 & DOO6: Corrosive Materials Waste & Cadmium					
Carcinogens:	arsenic	3.7	1.6	H	H
Non-carcinogens:	sulfuric acid	-1.2	2.7	H	H
	metals mix[3]	-1.3	4.3	M	H
D008: Lead Waste					
Non-carcinogens:	lead	1.3	-1.0	M	H
F001: Spent Halogenated Solvents Used in Degreasing					
Carcinogens:	dichloroethane	2.4	2.3	H	L
Non-carcinogens:	1,1,1-trichloroethane	-0.5	2.3	M	M
F006: Wastewater Treatment Sludges from Electroplating, Except Aluminum, Tin or Zinc					
Non-carcinogens:	metals mix 1[4]	0.6	-0.1	H	H
	cyanide	0.2	-1.1	H	M
	metals mix 2[5]	0.4	-0.6	M	H
F019: Waste from the Chemical Converson Coating of Aluminum					
Non-carcinogens:	metals mix 1[4]	-0.1	-1.5	H	H
	cyanide	0.2	-0.3	H	M
	metals mix 2[6]	-0.8	-1.7	M	H
K048, K049, K050, K051: Sludges from the Petroleum Refining Industry					
Carcinogens:	arsenic	3.7	-2.2	H	H
	benzene	2.0	-1.2	M	L
Non-carcinogens:	metals mix 1[4]	0.3	-0.6	H	H
	metals mix 2[7]	0.8	-0.6	M	H

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Storage Piles

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
K061: Emission Control Dust/Sludges from Steel Production					
Carcinogens:	arsenic	3.7	-1.3	H	H
Non-carcinogens:	chromium (VI)	0.8	0.0	H	H
	metals mix[5]	0.6	-0.8	M	H
NONHAZARDOUS WASTE PILES					
Non-carcinogens:	chromium	0.7	-0.4	H	H
	metals mix[8]	0.6	-0.8	M	H
MATERIAL STOCKPILES					
Carcinogens:	arsenic	3.7	-5.5	H	H
Non-carcinogens:	metals mix 1[9]	-0.8	-1.7	H	H
	metals mix 2[10]	0.4	-3.2	M	H
MINE WASTE PILES					
Copper Sector					
Carcinogens:	arsenic	3.7	-5.4	H	H
Non-carcinogens:	metals mix[11]	1.4	-3.9	M	H
Lead Sector					
Carcinogens:	arsenic	3.7	-5.5	H	H
Non-carcinogens:	metals mix[11]	1.3	-1.8	M	H
Zinc/Zinc Oxide					
Carcinogens:	arsenic	3.7	-5.2	H	H
Non-carcinogens:	manganese	-0.8	-4.0	H	H
	metals mix[11]	1.6	-2.3	M	H
Aluminum Sector					
Carcinogens:	arsenic	3.7	-4.5	M	H

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Storage Piles

NOTES:

[1] chromium, manganese and barium
[2] nickel, vanadium, mercury, iron, cadmium, zinc, berylium, silver and lead
[3] tin and lead
[4] chromium and barium
[5] nickel, lead, zinc and cadmium
[6] nickel and zinc
[7] cyanide, vanadium, lead and zinc
[8] chromium, nickel, cadmium, zinc and lead
[9] chromium and manganese
[10] lead, nickel, berylium, cadmium, iron and mercury
[11] cadmium and lead

REFERENCES:

Heap Leaching Piles:	29
Hazardous Waste Piles:	15, 22, 23, 24, 62
Nonhazardous Waste Piles:	27
Material Stockpiles:	49
Mine Waste Piles:	61

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contamianant/Mixture and Source Category

Source Category: Surface Impoundments

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
Hazardous Waste ("Subtitle C")					
Carcinogens:	arsenic	3.7	-1.8	H	H
	benzene	2.0	-0.3	M	L
Non-carcinogens:	chromium	0.7	-1.3	H	H
	metals mix[1]	1.3	-1.0	M	H
Industrial Waste ("Subtitle D")					
Carcinogens:	chloroform	1.2	-3.6	H	M
	organics mix[2]	1.8	-3.2	M	L
Non-carcinogens	nitrobenzene	1.8	-3.6	H	L
Municipal Waste Treatment Ponds ("Subtitle D")					
Carcinogens:	chloroform	1.2	-4.8	H	M
	benzene	2.0	-4.7	M	M
Non-carcinogens:	chromium	0.7	-3.8	H	H
ANIMAL FEEDLOTS					
Dirt Lot Runoff:					
Non-carcinogens:	nitrate	-1.5	-1.5	H	M
Paved Lot:					
Non-carcinogens:	nitrate	-1.5	-0.4	H	M
MINE TAILING PONDS					
Copper Sector:					
Carcinogens:	arsenic	3.7	-1.8	H	H
Non-carcinogens:	manganese	-0.8	-1.7	H	H
	metals mix[3]	1.7	-1.6	M	H
Lead Sector:					
Carcinogens:	arsenic	3.7	-4.5	H	H
Non-carcinogens:	metals mix[3]	1.6	-2.4	M	H

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Surface Impoundments

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
Zinc/Zinc Oxide:					
Carcinogens:	arsenic	3.7	-5.2	H	H
Non-carcinogens:	metals mix[3]	1.5	-3.1	M	H
Aluminium Sector:					
Carcinogens:	arsenic	3.7	-3.0	H	H
Urban Stormwater Retention Ponds					
Carcinogens:	arsenic	3.7	1.4	H	H
Non-carcinogens:	chromium	0.7	2.0	H	H
	metals mix[4]	0.2	2.0	M	H

NOTES:
[1] cyanide, cadmium and lead
[2] benzene, and 2,4,6 trichlorophenol
[3] cadmium and lead
[4] zinc, lead, cadmium and nickel

REFERENCES:
Hazardous Waste (Subtitle C): 21
Industrial Waste (Subtitle D): 21
Municipal Waste Treatment Ponds (Subtitle D): 28
Animal Feedlots: 48
Mine Tailing Ponds: 61
Urban Stormwater Retention Ponds: 70

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Tanks

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
HAZARDOUS WASTE TREATMENT/DISTILLATION					
D001: Ignitable Wastes					
Carcinogens:	benzene	2.0	2.1	M	L
Non-carcinogens:	methanol	-1.2	2.0	H	H
	organics mix[1]	-0.4	2.5	H	L
F003: Spent, Non-Halogenated Solvents					
Carcinogens:	benzene	2.0	2.0	M	L
Non-carcinogens:	methyl ethyl ketone	-0.2	2.0	H	L
	organics mix[2]	-0.8	2.3	M	L
X907: Chlorinated Pesticide Production Wastes					
Carcinogens:	chloroform	1.2	2.0	H	M
	hexachlorobenzene	3.7	2.0	M	M
Non-carcinogens:	hexachloro-cyclopentadiene	0.6	2.0	M	M
OXIDATION/REDUCTION PRECIPITATION					
D007: Chromium Waste					
Non-carcinogens:	chromium	0.7	-0.3	H	H
F006: Wastewater Treatment Sludges from Electroplating					
Non-carcinogens:	chromium	0.7	0.8	H	H
	metals mix[3]	0.2	0.6	M	H
K048: Dissolved Air Flotation Waste From the Petroleum Refining Industry					
Non-carcinogens:	chromium	0.7	-2.4	H	H
	lead	1.3	-1.6	M	H
HAZARDOUS WASTE STORAGE/ACCUMULATION					
D001: Ignitable Wastes					
Carcinogens:	benzene	2.0	2.1	M	L
Non-carcinogens:	methanol	-1.2	2.0	H	H
	organics mix[1]	-0.4	2.5	H	L

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Tanks

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
D002: Corrosive Wastes					
Non-carcinogens:	methanol	-1.2	1.6	H	H
	toluene	-1.0	1.6	M	L
F001: Spent, Halogenated Solvents Used for Degreasing					
Carcinogens:	chloroform	1.2	2.0	H	M
	carbon tetrachloride	2.5	2.0	M	L
Non-carcinogens:	organics mix[4]	-0.3	2.5	M	M
F003: Spent, Non-Halogenated Solvents					
Carcinogens:	benzene	2.0	2.0	M	L
Non-carcinogens:	methyl ethyl ketone	-0.2	2.0	H	L
RCRA PERMITTED STORAGE					
D001: Ignitable Wastes					
Carcinogens:	benzene	2.0	2.1	M	L
Non-carcinogens:	methanol	-1.2	2.0	H	H
	organics mix[1]	-0.4	2.5	H	M
F003: Spent, Non-halogenated Solvents					
Carcinogens:	benzene	2.0	2.0	M	L
Non-carcinogens:	methyl ethyl ketone	-0.2	2.0	H	L
X500: Ignitable Waste Mixtures					
Carcinogens:	benzene	2.0	2.0	M	L
Non-carcinogens:	organics mix[1]	-0.4	2.4	H	L
X501: Corrosive Waste Mixtures					
Non-carcinogens:	chromium mix[5]	-1.2	1.6	H	H
	lead	1.3	-1.0	M	H
X504: Toxic Waste Mixtures					
Carcinogens:	chloroform	1.2	2.0	H	M
	carbon tetrachloride	2.5	2.0	M	L
Non-carcinogens:	organics mix[6]	-0.2	2.3	M	M

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Tanks

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
SMALL QUANTITY GENERATORS					
Above Ground Tanks					
Stream 1: Holgenated Spent Solvents and Ignitable Wastes					
Carcinogens:	chloroform	1.2	2.0	H	M
	carbon tetrachloride	2.5	2.0	M	L
Non-carcinogens:	1,1,1-trichloroethane	-0.5	2.0	M	M
Stream 2: Non-Halogenated Spent Solvents and Ignitable Wastes					
Carcinogens:	benzene	2.0	2.0	M	L
Non-carcinogens:	organics mix[1]	-0.4	2.4	H	L
Stream 3: Strong Acid or Alkaline Waste					
Non-carcinogens:	lead	1.3	-0.3	M	H
Below Ground Tanks					
Stream 1: Halogenated Spent Solvents and Ignitable Wastes					
Carcinogens:	chloroform	1.2	2.0	H	M
	carbon tetrachloride	2.5	2.0	M	L
Non-carcinogens:	1,1,1-trichloroethane	-0.5	2.0	M	M
Stream 2: Non-halogenated Spent Solvents and Ignitable Wastes					
Carcinogens:	benzene	2.0	2.0	M	L
Non-carcinogens:	organics mix[1]	-0.4	0.5	H	L
Stream 3: Strong Acid or Alkaline Waste					
Non-carcinogens:	lead	1.3	-0.3	M	H
PRODUCT STORAGE					
Petroleum (gasoline)					
Carcinogens:	benzene	2.0	-2.7	M	L
Petroleum (diesel)					
Carcinogens:	benzene	2.0	-2.7	M	L
Chemical/Cleaning Liquids (corrosive)					
Non-carcinogens:	acetic acid	-1.5	2.4	H	L

Form S.2
Toxicity, Concentration, Mobility and Persistence Scores by Contaminant/Mixture and Source Category

Source Category: Tanks

	Contaminant	Toxicity Score	Conc. Score	Mobility	Persistence
Sulfuric Acid					
Non-carcinogens:	sulfuric acid	-1.2	3.3	H	H
Paint Dryer (flammable)					
Carcinogens:	benzene	2.0	2.9	M	L
Non-carcinogens:	organics mix 1[7]	-0.2	3.2	H	L
	organics mix 2[8]	-0.4	3.3	M	L
MUNICIPAL ("SUBTITLE D") WASTEWATERS					
Carcinogens:	chloroform	1.2	-4.8	H	M
	benzene	2.0	-4.7	M	L
	bis(2-ethylhexyl)phtalate	1.5	-4.3	L	H
Non-carcinogens:	chromium	0.7	-3.8	H	H

NOTES:

1. acetone and methyl ethyl ketone
2. xylene and toluene
3. cadmium, lead and nickel
4. 1,2-dichlorobenzene
5. chromium and methanol
6. 1,1,1-trichloroethane
7. methyl ethyl ketone, cresol and acetone
8. xylene, napthalene, toluene and 1,1,1-trichloroethane

REFERENCES:

Hazardous Waste Treatment, Hazardous Waste Storage and Small Quantity Generators: 25
Product Storage:
Petroleum: 12
Chemical: 25, 40
Municipal Wastewaters: 28

CHAPTER 4: SOURCE DATASHEETS, SOURCE WORKSHHEETS, AND TRANSPORT WORKSHEET

SOURCE DATASHEET - AGRICHEMICAL APPLICATION

Source #: _____ Author: _____

Source Name: _____ Date: _____

Location: _____

PARAMETER	INSTRUCTIONS*	VALUE
DESIGN PARAMETERS		
SD1 Age of Source	Indicate the number of years agrichemicals have been applied to the crop land	_____ years
SD2 Area of Application	Indicate the number of acres within the WHPA to which agrichemicals are applied.	_____ acres

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - AGRICHEMICAL APPLICATION (continued)

PARAMETER	INSTRUCTIONS*	VALUE
HYDROGEOLOGIC SETTINGS		
SD3 Distance Score	Use the table below to determine the Distance Score as a function of the shortest distance from the area of agrichemical application to the well (or to an abandoned well if one exists between the area of agrichemical application and the well). For example, if the shortest distance between the area of agrichemical application and the well is 1,000 feet, then the Distance Score is equal to 2.	_____

Distance Scoring Form

Distance from Source to Well	(Miles)	0 - .12	.12 - .25	.25 - .5	.5 - 1.0	1.0 - 3.0	3.0 - 5.0
	(Feet)	0 - 635	635 - 1320	1320 - 2640	2640 - 5280	5280 - 15,840	15,840 - 26,400
	(Meters)	0 - 193	193-402	402 - 805	805 - 1610	1610 - 4829	4829 - 8040
Distance Score		1	2	3	4	5	6

SD4 Does the source discharge directly to a conduit system (e.g., pipes or utility chase) that could transport contaminants directly to the well?	Yes or No	_____

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - AGRICHEMICAL APPLICATION (continued)

PARAMETER	INSTRUCTIONS*	VALUE

CONTAMINANT PARAMETERS

SD5 Contaminant Data

Complete the Contaminant Data Table below for all pesticides and fertilizers that are applied to crop land. If you know the pesticides and fertilizers that are applied as well as their application rates (expressed in units of kilograms/hectare/year), then use Contaminant Form S.1. Since a particular agrichemical may be used sporadically, multiply its application rate by the percentage of time that it is used. For example, if the pesticide Metolachor has been applied for three years on a a farm that has used agrichemicals for 15 years, then multiply the application rate of Metolachor by 0.2 (i.e., the percentage of time that Metolachor has been used, or 3 divided by 15). If you do not know which pesticides and fertilizers are applied, then use Contaminant Form S.2. Form S.2 provides default pesticides and fertilizers and their contaminant scores by various crop types. Keeping in mind that crops may be rotated, enter onto the Contaminant Data Table below all pesticides and fertilizers that are applied to the crop land.

Contaminant Data Table

	Contaminant/Mixture Score	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
1.					
2					
3					

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE WORKSHEET
AGRICHEMICAL APPLICATION

Step 6

SOURCE # _____

SOURCE WORKSHEET - AGRICHEMICAL APPLICATION

STEP	INSTRUCTIONS	SCORE

LIKELIHOOD OF RELEASE (L_1)

Step 1 Likelihood of Release (L_1) Score

Set $L_1 = 0$.

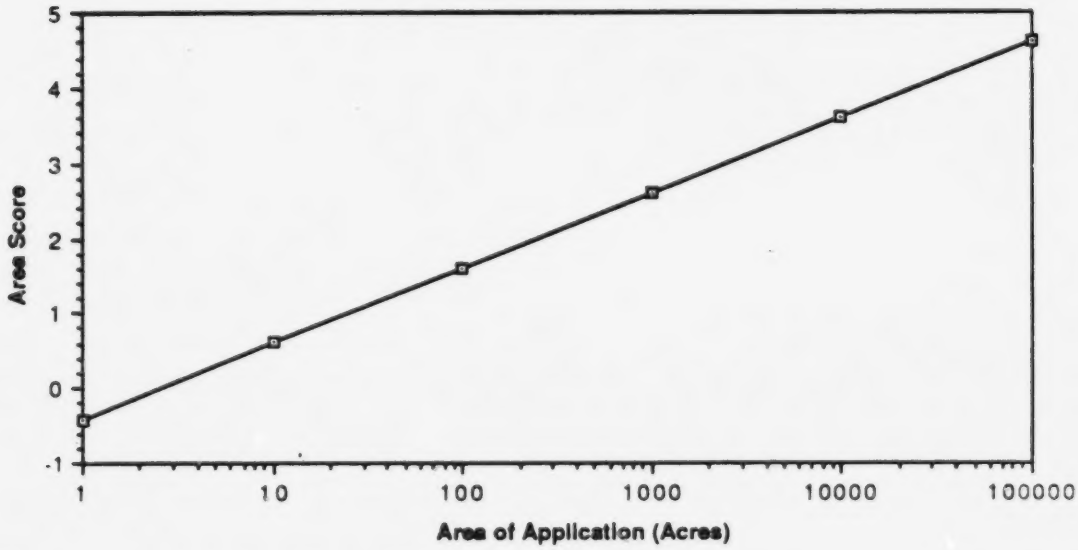
Likelihood of Release (L_1) Score = 0

QUANTITY (Q)

Step 2 Determine the Area Score

Use the graph below to determine the Area Score as a function of the Area of Application (SD2).

Area Score by Application Area



Area Score: _____

SOURCE WORKSHEET - AGRICHEMICAL APPLICATION (continued)

STEP	INSTRUCTIONS	SCORE

Step 3 Compute the Quantity Score (Q) for Each Contaminant

Quantity Score (Q) = Concentration Score (SD5) + Area Score (Step 2)

Contaminant or Contaminant Mixture	Quantity Score (Q)
(1) _____	_____
(2) _____	_____
(3) _____	_____

SOURCE DATASHEET - CONTAINER STORAGE AND MATERIAL TRANSFER Step 5

Source #: _____ Author: _____

Source Name: _____ Date: _____

Location: _____

PARAMETER	INSTRUCTIONS*	VALUE
DESIGN PARAMETERS		
SD1 Throughput Cateogry	Enter 1, 2, 3, 4, or 5 to indicate the number of 55-gallon drums passing through the storage and/or transfer facilities in one year, where: 1 = 1-10 Drums 2 = 11-100 Drums 3 = 101-500 Drums 4 = 501-1000 Drums 5 = 1000+ Drums	_____
SD2 Duration of Storage	Enter Low, Medium, or High for the average duration of storage of the 55-gallon drums where: Low = < 30 days Medium = 31 days - 1 year; or High = 1 year+ If materials are just transferred and not stored, enter Low.	_____
SD3 Storage Area Design	Indicate whether the storage area is padded or unpadded.	_____
SD4 Container Storage and/ or Material Transfer Age	Enter the number of years that hazardous materials have been stored and/or transferred within the WHPA.	_____

Container Storage And Material Transfer

* For additional guidance, especially for contaminant-specific data (SD7), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - CONTAINER STORAGE AND MATERIAL TRANSFER (continued)

PARAMETER	INSTRUCTIONS*	VALUE

HYDROGEOLOGIC SETTINGS

SD5 Distance Score

Use Contaminant Form S.1 to determine the Distance Score as a function of the distance from the container storage area to the well (or to an abandoned well if one exists between the source and the well). For example, if the distance between the source and the well is 175 meters, then the Distance Score is equal to 1.

_____

Distance Scoring Form

Distance from Source to Well	(Miles)	0 - .12	.12 - .25	.25 - .5	.5 - 1.0	1.0 - 3.0	3.0 - 5.0
	(Feet)	0 - 635	635 - 1320	1320 - 2640	2640 - 5280	5280 - 15,840	15,840 - 26,400
	(Meters)	0 - 193	193-402	402 - 805	805 - 1610	1610 - 4829	4829 - 8040
Distance Score		1	2	3	4	5	6

SD6 Does the source discharge directly to a conduit system (e.g., pipes or utility chase) that could transport contaminants directly to the well?

Yes or No

_____

* For additional guidance, especially for contaminant-specific data (SD7), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - CONTAINER STORAGE AND MATERIAL TRANSFER (continued)

PARAMETER	INSTRUCTIONS*	VALUE

CONTAMINANT PARAMETERS

SD7 Contaminant Data

Use Contaminant Forms S.1 or S.2 to complete the Contaminant Data Table below. Refer to Task 2 of the User's Guide for additional guidance.

Contaminant Data Table

	Contaminant/Mixture Score	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
1					
2					
3					

* For additional guidance, especially for contaminant-specific data (SD7), refer to the User's Guide (Chapter 2).

SOURCE WORKSHEET
CONTAINER STORAGE AND
MATERIAL TRANSFER

SOURCE # _____

SOURCE WORKSHEET - CONTAINER STORAGE AND MATERIAL TRANSFER

STEP	INSTRUCTIONS	SCORE

LIKELIHOOD OF RELEASE (L_1)

Step 1 Determine the Likelihood of Release (L_1) Score

Use the table below to determine the Likelihood of Release (L_1) Score as a function of the Throughput Category (SD1), Duration of Storage (SD2), and Storage Area Design (SD3).

Likelihood of Release Score by Throughput Category, Duration of Storage, and Storage Area Design

Duration of Storage	Storage Area Design	Throughput Category				
		1	2	3	4	5
Low	Not Applicable	-2.8	-1.8	-1.1	-0.7	-0.4
Medium	Unpadded	-2.1	-1.6	-1.2	-1.0	-0.9
	Padded	-2.6	-2.1	-1.7	-1.5	-1.4
High	Unpadded	-1.3	-1.3	-1.3	-1.3	-1.3
	Padded	-2.3	-2.3	-2.3	-2.3	-2.3

Likelihood of Release (L_1) Score = _____

SOURCE WORKSHEET - CONTAINER STORAGE AND MATERIAL TRANSFER (continued)

STEP	INSTRUCTIONS	SCORE

QUANTITY (Q)

Step 2 Determine the Volume Score

Use the table below to determine the Volume Score as a function of the Throughput Category (SD1) and Duration of Storage (SD2).

Volume Score by Throughput Category and Duration of Storage

Duration of Storage	Throughput Category				
	1	2	3	4	5
Low	-0.7	-0.7	-0.7	-0.7	-0.7
Medium	-0.7	-0.2	0.2	0.3	0.8
High	-0.7	0.3	1.0	1.3	2.3

Volume Score: _____

Step 3 Compute the Quantity Score (Q) for Each Contaminant

Quantity Score (Q) = Concentration Score (SD7) + Volume Score (Step 2)

Contaminant or Contaminant Mixture	Quantity Score (Q)
(1) _____	_____
(2) _____	_____
(3) _____	_____

SOURCE DATASHEET - DEEP INJECTION WELLS (CLASSES I, II, III) Step 5

Source #: _____ Author: _____

Source Name: _____ Date: _____

Location: _____

PARAMETER	INSTRUCTIONS*	VALUE

This datasheet covers Injection Wells falling into one of the following classes:

Class I: Wastewater disposal
Class II: Oil and gas activity
Class III: Mineral extraction

Injection Wells- Deep Wells (Class I, II, III)

Class IV Wells have been banned and are not covered in this manual. However, if you have a Class IV well in the WHPA, you should consider it a high risk and should investigate further. Class V wells are covered in the "Shallow Injection/Drainage Well" source category.

DESIGN PARAMETERS

SD1 Well Age _____ years

SD2 Throughput Rate

Determine the amount of liquid injected into the well annually _____ mgy

Typical default values for each well class are:

Class I: 20.7 million gallons/year (Ref. 54)
Class II: 5.3 million gallons/year (Ref. 63)
Class III: 19.4 million gallons/year (Refs. 13 and 71)

A typical default value for the number of wells in a Class III mining operation is 110. Therefore, the Throughput Rate for a 110-well mining operation is 2,139 million gallons/year (Ref. 71).

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - DEEP INJECTION WELLS (CLASSES I, II, III) (continued)

PARAMETER	INSTRUCTIONS*	VALUE

HYDROGEOLOGIC SETTINGS

SD3 Distance Score

Use the table below to determine the Distance Score as a function of the shortest distance from the injection well to the well (or to an abandoned well if one exists between the injection well and the well). For example, if the shortest distance between the injection well and the well is between 1/4 and 1/2 mile, then the Distance Score is equal to 3.

_____

Distance Scoring Form

Distance from Source to Well	(Miles)	0 - .12	.12 - .25	.25 -.5	.5 - 1.0	1.0 - 3.0	3.0 - 5.0
	(Feet)	0 - 635	635 - 1320	1320 - 2640	2640 - 5280	5280 - 15,840	15,840 - 26,400
	(Meters)	0 - 193	193-402	402 - 805	805 - 1610	1610 - 4829	4829 - 8040
Distance Score		1	2	3	4	5	6

SD4 Does the source discharge directly to a conduit system (e.g., pipes or utility chase) that could transport contaminants directly to the well?

Yes or No

_____

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - DEEP INJECTION WELLS (CLASSES I, II, III) (continued)

PARAMETER	INSTRUCTIONS*	VALUE

CONTAMINANT PARAMETERS

SD5 Contaminant Data

Use Contaminant Forms S.1 or S.2 to complete the Contaminant Data Table below. Refer to Task 2 of the User's Guide for additional guidance.

Contaminant Data Table

	Contaminant/Mixture Score	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
1					
2					
3					

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE WORKSHEET
INJECTION WELLS: DEEP WELLS
(CLASSES I, II, AND III)

Step 6

SOURCE # _____

SOURCE WORKSHEET - DEEP INJECTION WELLS

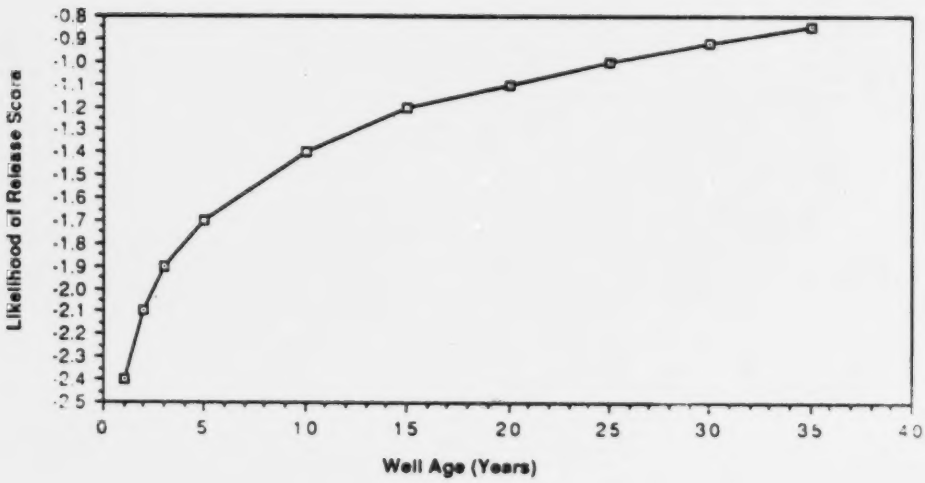
STEP	INSTRUCTIONS	SCORE

LIKELIHOOD OF RELEASE (L_1)

Step 1 Determine the Likelihood of Release (L_1) Score

Use the graph below to determine the Likelihood of Release (L_1) Score as a function of Well Age (SD1).

Likelihood of Release Score by Well Age



Likelihood of Release (L_1) Score = _____
(Ref. 21)

SOURCE WORKSHEET - DEEP INJECTION WELLS (continued)

STEP	INSTRUCTIONS	SCORE

QUANTITY (Q)

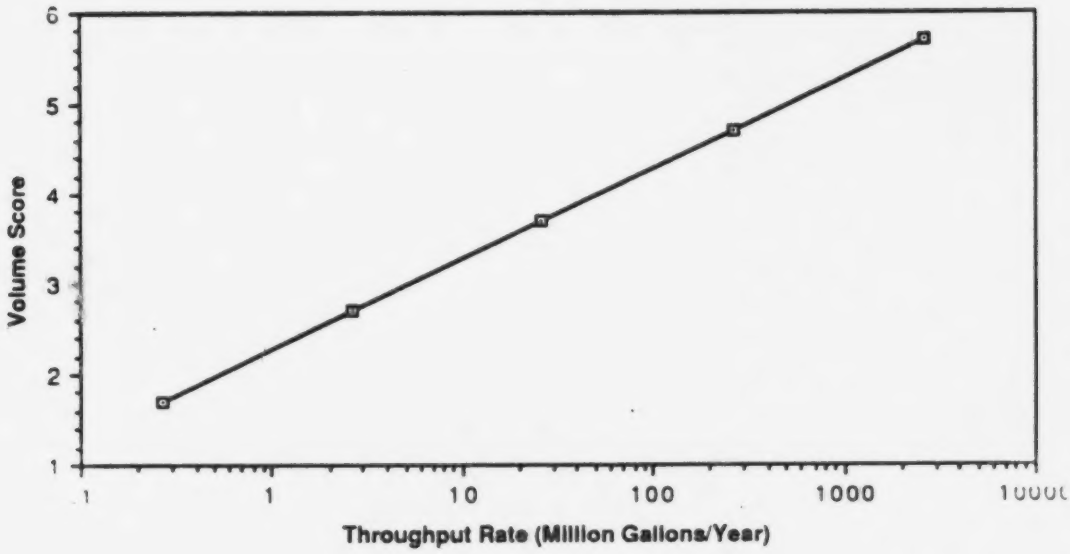
Step 2 **Determine the Volume Score**

Determine the Volume Score for the well based on Throughput Rate (SD2). If you are using default values for the Throughput Rate, the corresponding default values for the Volume Score are as follows:

Class I: 3.8 (Refs. 21 and 54)
Class II: 3.2 (Refs. 21 and 63)
Class III: 3.8 for a single well in a mining operation
5.8 for a 110-well mining operation
(Refs. 21, 13, and 71)

If you are using a site-specific rate, use the graph below to determine the Volume Score.

Volume Score by Throughput Rate



Volume Score: _____

SOURCE WORKSHEET - DEEP INJECTION WELLS (continued)

STEP	INSTRUCTIONS	SCORE

Step 3 Compute the Quantity Score (Q) for Each Contaminant

Quantity Score (Q) = Concentration Score (SD5) + Volume Score (Step 2)

Contaminant or Contaminant Mixture	Quantity Score (Q)
(1) _____	_____
(2) _____	_____
(3) _____	_____

Step 4 Set L_U and A_U in Transport Worksheet Equal to 0

Steps 4 and 6 of the Transport Worksheet provide guidance for determining L_U and A_U for each contaminant/mixture at each source. For Deep Injection Wells, override the L_U and A_U calculations in those steps and set L_U and A_U equal to 0 for each contaminant/mixture.

SOURCE DATASHEET - INJECTION WELLS: SHALLOW WELLS (CLASS V) Step 5

Source #: _____ Author: _____

Source Name: _____ Date: _____

Location: _____

PARAMETER	INSTRUCTIONS*	VALUE

This datasheet covers a wide variety of drainage wells that fall under the category of Class V Injection Wells. Specifically, in this datasheet, you can evaluate:

1. Automobile Service Station Disposal Wells (5X28)
2. Industrial Process Water and Water Disposal Wells (5W20)
3. Agricultural Drainage Wells (5F01).

Note that Injection Wells falling into Classes I-III are covered in the "Deep Injection Well" source category. Also, Class IV wells have been banned and are not covered in this manual. However, if you have Class IV wells in the WHPA, you should consider them as high risk and investigate them further. Class V Storm Water Drainage Wells (5DO2) are covered in the "Surface Impoundment" source category.

DESIGN PARAMETERS

SD1 Well Age

_____ years

SD2 Throughput Rate

Determine the amount of liquid drained or injected into the well annually. Default Volume Scores are provided below. If wells are clustered at the source, add all the throughput rates to get an aggregate Throughput Rate.

_____ million gallons/year

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - INJECTION WELLS: SHALLOW WELLS (CLASS V) (continued)

PARAMETER	INSTRUCTIONS*	VALUE

1. Automobile Service Station Disposal Wells: A typical default value is 0.6 million gallons/year (Ref. 69).

   Use for the following industries: car washes, auto body repair shops, car dealerships, and specialty repair shops (transmission, muffler, etc.).

2. Industrial Process Water and Water Disposal Wells: Industrial drainage throughput can vary significantly from facility to facility, so it is important to try to get the actual drainage throughput for the facility in your area. However, if that information is not available, you can select one of the following default values, based on facility type:

   Low Throughput (< 2.6 million gallons per year): 0.6 million gallons/year

   Use for the following industries: Measuring, Analyzing, and Controlling Instruments; Photographic, Medical and Optical Goods.

   Medium Throughput (2.6 - 31.2 million gallons per year): 9.4 million gallons/year

   Use for the following industries: Industrial Inorganic Chemicals; Laundry, Cleaning, and Garment Services.

   High Throughput (> 31.2 million gallons per year): 54.6 million gallons/year.

   Use for the following industries: Engraving and Allied Services - Electroplating Manufacturing Industries; NEC; Electric, Gas and Sanitary Services (Ref. 69).

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - INJECTION WELLS: SHALLOW WELLS (CLASS V) (continued)

PARAMETER	INSTRUCTIONS*	VALUE

3. Agricultural Drainage Wells: For agricultural drainage wells, determine the total area being drained in acres.

Area: _____ acres

With this information and with the net infiltration rate parameter (WD4) from the Wellhead Datasheet, use the following table to determine the Throughput Rate for the drainage well.

Assume a Net Infiltration of > 15 inches if the agricultural well is irrigated.

Agricultural Drainage Well Throughput Rate by Area and Net Infiltration (Million Gallons/Year) (Ref. 70)

Area (Acres)	Net Infiltration (Inches)			
	< 0.6	0.6 - 6	6 - 15	> 15
< 10	0.0068	0.027	0.27	0.54
10 - 100	0.068	0.27	2.7	5.4
101 - 1,000	0.68	2.7	27	54
1,001 - 10,000	6.8	27	270	540
10,001 - 100,000	68	270	2,700	5,400
> 100,000	680	2,700	27,000	54,000

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - INJECTION WELLS: SHALLOW WELLS (CLASS V) (continued)

PARAMETER	INSTRUCTIONS*	VALUE
HYDROGEOLOGIC SETTINGS		
SD3 Distance Score	You will need to look up the Distance Score on Form S.1, as a function of the shortest distance from the injection well to the well (or to an abandoned well if one exists between the injection well and the well). For example, if the shortest distance between the injection well and the well is between 1/4 and 1/2 mile, then the Distance Score is equal to 3.	_____

Distance Scoring Form

Distance from Source to Well	(Miles)	0 - .12	.12 - .25	.25 -.5	.5 - 1.0	1.0 - 3.0	3.0 - 5.0
	(Feet)	0 - 635	635 - 1320	1320 - 2640	2640 - 5280	5280 - 15,840	15,840 - 26,400
	(Meters)	0 - 193	193-402	402 - 805	805 - 1610	1610 - 4829	4829 - 8040
Distance Score		1	2	3	4	5	6

SD4 Does the source discharge directly to a conduit system (e.g., pipes or utility chase) that could transport contaminants directly to the well?	Yes or No	_____

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - INJECTION WELLS: SHALLOW WELLS (CLASS V) (continued)

PARAMETER	INSTRUCTIONS*	VALUE

CONTAMINANT PARAMETERS

SD5 Contaminant Data

Use Contaminant Form S.1 or S.2 to complete the Contaminant Data Table below. Refer to Task 2 of the User's Guide for additional guidance.

Contaminant Data Table

	Contaminant/Mixture Score	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
1					
2					
3					

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE WORKSHEET
INJECTION WELLS: SHALLOW WELLS
(CLASS V)

Step 6

SOURCE # _____

SOURCE WORKSHEET - INJECTION WELLS: SHALLOW WELLS

STEP	INSTRUCTIONS	SCORE

LIKELIHOOD OF RELEASE (L_1)

Step 1 Determine the Likelihood of Release (L_1) Score

The Likelihood of Release (L_1) Score is 0 for all Shallow Injection/Drainage Wells.

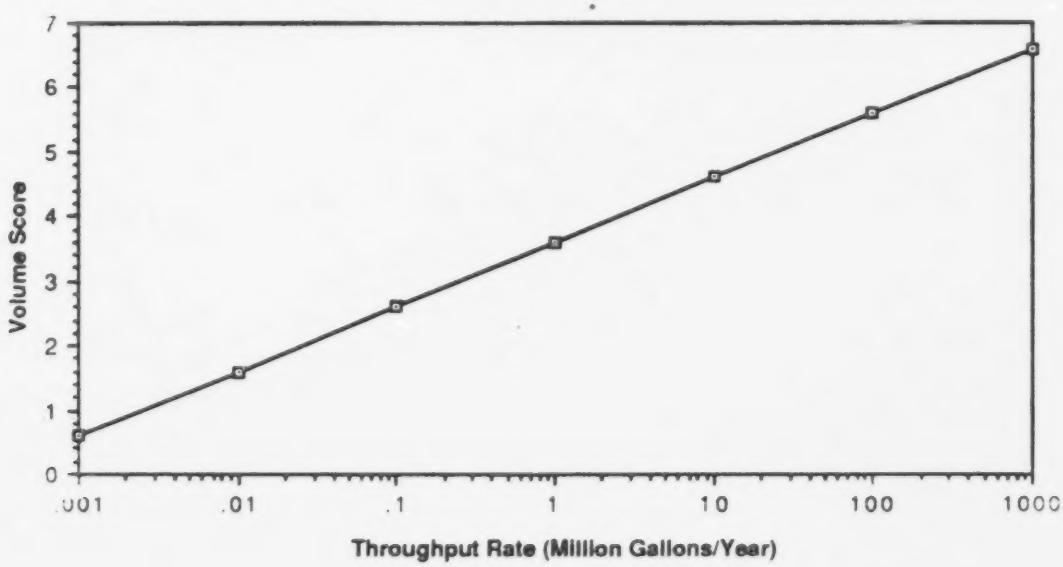
Likelihood of Release (L_1) Score = 0

QUANTITY (Q)

Step 2 Determine the Volume Score

Use the graph below to determine the Volume Score for the well or cluster of wells based on the Throughput Rate (SD2).

Volume Score by Throughput Rate



Volume Score: _____

SOURCE WORKSHEET - INJECTION WELLS: SHALLOW WELLS (continued)

STEP	INSTRUCTIONS	SCORE

Step 3 Compute the Quantity Score (Q) for Each Contaminant

Quantity Score (Q) = Concentration Score (SD5) + Volume Score (Step 2)

Contaminant or Contaminant Mixture	Quantity Score (Q)
(1) _____	_____
(2) _____	_____
(3) _____	_____

SOURCE DATASHEET - LAND TREATMENT

Step 5

Source #: _____ Author: _____

Source Name: _____ Date: _____

Location: _____

PARAMETER	INSTRUCTIONS*	VALUE
DESIGN PARAMETERS		
SD1 Unit Age	Indicate the age of the land treatment unit in years.	_____ years
SD2 Land Treatment Area	Provide the number of acres within the WHPA to which wastes are applied. A typical land treatment unit has an area of 15 acres (Ref. 10).	_____ acres
SD3 Waste Application Score	Obtain the Waste Application Score as a function of the average waste application rate as follows: 0-10 wet tons/acre, enter 1 11-100 wet tons/acre, enter 2 101-500 wet tons/acre, enter 3 501-1000 wet tons/acre, enter 4 > 1000 wet tons/acre, enter 5 For inactive land treatment units, assume a Waste Application Score of 1. A typical Waste Application Score for the petroleum refining and inorganic chemical industries is 2. A typical Waste Application Score for the organic chemical industry is 1 (Ref. 11).	_____

Land Treatm

* For additional guidance, especially for contaminant-specific data (SD6), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - LAND TREATMENT (continued)

PARAMETER	INSTRUCTIONS*	VALUE

HYDROGEOLOGIC SETTINGS

SD4 Distance Score

Use the table below to determine the Distance Score as a function of the shortest distance from the land treatment unit area to the well (or to an abandoned well if one exists between the land treatment unit and the well). For example, if the shortest distance between the land treatment area and the well is between 1/4 and 1/2 mile, then the Distance Score is equal to 3.

_____

Distance Scoring Form

Distance from Source to Well	(Miles)	0 - .12	.12 - .25	.25 -.5	.5 - 1.0	1.0 - 3.0	3.0 - 5.0
	(Feet)	0 - 635	635 - 1320	1320 - 2640	2640 - 5280	5280 - 15,840	15,840 - 26,400
	(Meters)	0 - 193	193-402	402 - 805	805 - 1610	1610 - 4829	4829 - 8040
Distance Score		1	2	3	4	5	6

SD4 Does the source discharge directly to a conduit system (e.g., pipes or utility chase) that could transport contaminants directly to the well?

Yes or No

_____

* For additional guidance, especially for contaminant-specific data (SD6), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - LAND TREATMENT (continued)

PARAMETER	INSTRUCTIONS*	VALUE

CONTAMINANT PARAMETERS

SD6 Contaminant Data

Use Contaminant Form S.1 or S.2 to complete the Contaminant Data Table below. Refer to Task 2 of the User's Guide for additional guidance.

Contaminant Data Table

	Contaminant/Mixture Score	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
1					
2					
3					

* For additional guidance, especially for contaminant-specific data (SD6), refer to the User's Guide (Chapter 2).

SOURCE WORKSHEET
LAND TREATMENT

SOURCE # _____

SOURCE WORKSHEET - LAND TREATMENT

STEP	INSTRUCTIONS	SCORE

LIKELIHOOD OF RELEASE (L_1)

Step 1 Likelihood of Release (L_1) Score

Set $L_1 = 0$.

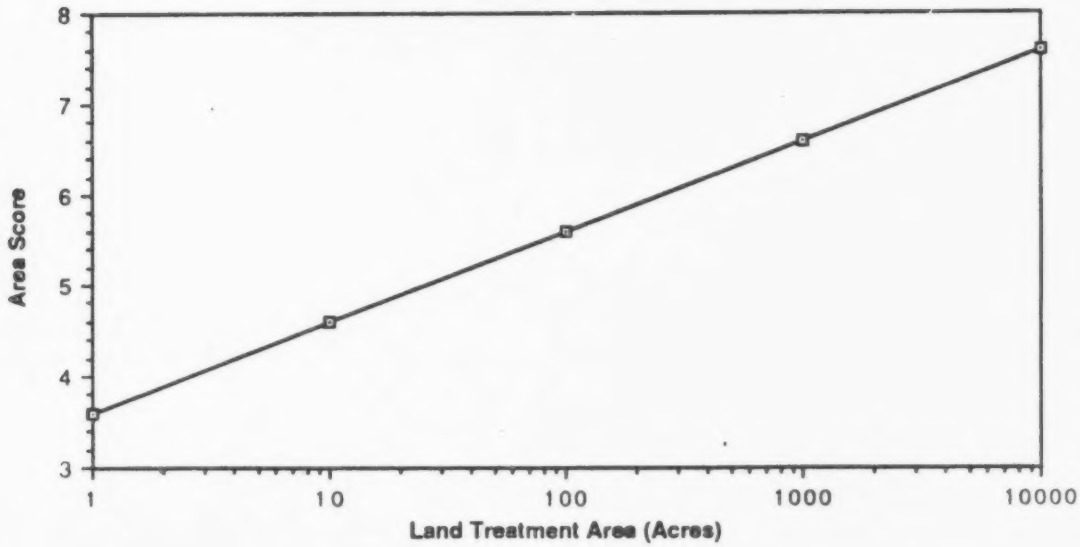
Likelihood of Release (L_1) Score = 0

QUANTITY (Q)

Step 2 Determine the Area Score

Use the graph below to determine the Area Score as a function of Land Treatment Area (SD2).

Area Score by Land Treatment Area



Area Score: _____

SOURCE WORKSHEET - LAND TREATMENT (continued)

STEP	INSTRUCTIONS	SCORE

Step 3 Determine the Release Score

Use the table below to determine the Release Score as a function of the Waste Application Score (SD3) and Net Infiltration (WD4).

Release Score by Waste Application Score and Net Infiltration

Waste Application Score	Net Infiltration (Inches)			
	< 0.6	0.6 - 6	6 - 15	≥ 15
1	-2.2	-1.6	-0.6	-0.3
2	-1.9	-1.5	-0.6	-0.3
3	-1.4	-1.2	-0.5	-0.3
4	-1.1	-1.0	-0.5	-0.2
5	-0.8	-0.7	-0.4	-0.2

Release Score: _____
(Ref. 70)

Step 4 Compute the Volume Score

Volume Score = Release Score (Step 3)
+ Area Score (Step 2)

Volume Score: _____

Step 5 Compute the Quantity Score (Q) for Each Contaminant

Quantity Score (Q) = Volume Score (Step 4)
+ Concentration Score (SD6)

Contaminant or Contaminant Mixture	Quantity Score (Q)
(1) _____	_____
(2) _____	_____
(3) _____	_____

SOURCE DATASHEET - LANDFILLS

Step 5

Source #: _____ Author: _____

Source Name: _____ Date: _____

Location: _____

PARAMETER	INSTRUCTIONS*	VALUE
LANDFILL DESIGN PARAMETERS		
SD1 Landfill Design	Enter 1, 2, 3, 4, or 5 for the design of the landfill where: 1 = Unlined vegetative cover 2 = Clay-lined vegetative cover 3 = Synthetic liner + synthetic cover + leachate collection system 4 = Unlined + clay and synthetic cover 5 = Clay and synthetic liner + clay and synthetic cover + leachate collection system If the landfill design is unknown: Select "1" for all municipal waste landfills and hazardous (industrial) waste landfills with a last year of active operation prior to 1976; or select "5" for hazardous waste landfills with a last year of active operation after 1976 (Ref. 59). The table on the next page will help to determine the landfill design in Step SD1.	_____

* For additional guidance, especially for contaminant-specific data (SD8), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - LANDFILLS (continued)

PARAMETER	INSTRUCTIONS*	VALUE

Landfill Design Options by Last Year of Active Operation and Waste Type Managed

Last Year of Active Operation	Waste Type Managed*	Landfill Design Options
Prior to 1976	All Types	1, 2, 3
Post 1976	Hazardous Waste	4, 5
	Municipal Waste	1, 2, 3, 4, 5

* A landfill that receives hazardous waste is referred to as a "Subtitle C" landfill by current Federal regulations and a landfill that receives municipal waste is referred to as a "Subtitle D" landfill

SD2	Landfill Status	Enter 1, 2, or 3 for the status of of the landfill where: 1 = Active 2 = Post-closure care 3 = Abandoned or post-care	_____
SD3	Default Assumptions	Do you use a default assumption for either landfill design or landfill status? Circle either "yes" or "no."	Yes No
SD4	Landfill Age	Indicate the age of the landfill.	_____ years
SD5	Landfill Area	Estimate the landfill area, in acres. For landfills over 100 acres, round to the nearest 100 acres.	_____ acres

* For additional guidance, especially for contaminant-specific data (SD8), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - LANDFILLS (continued)

PARAMETER	INSTRUCTIONS*	VALUE

HYDROGEOLOGIC SETTINGS

SD6 Distance Score

Use the table below to determine the Distance Score as a function of the shortest distance from the landfill to the well (or abandoned well if one exists between the landfill and the well). For example, if the shortest distance between the landfill and the well is between 1/4 and 1/2 mile, then the Distance Score is equal to 3.

_____

Distance Scoring Form

Distance from Source to Well							
	(Miles)	0 - .12	.12 - .25	.25 -.5	.5 - 1.0	1.0 - 3.0	3.0 - 5.0
	(Feet)	0 - 635	635 - 1320	1320 - 2640	2640 - 5280	5280 - 15,840	15,840 - 26,400
	(Meters)	0 - 193	193-402	402 - 805	805 - 1610	1610 - 4829	4829 - 8040
Distance Score		1	2	3	4	5	6

SD7 Does the source discharge directly to a conduit system (e.g., pipes or utility chase) that could transport contaminants directly to the well?

Circle either "Yes" or "No"

Yes No

* For additional guidance, especially for contaminant-specific data (SD8), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - LANDFILLS (continued)

PARAMETER	INSTRUCTIONS*	VALUE

CONTAMINANT PARAMETERS

SD8 Contaminant Data

Use Contaminant Form S.1 to complete the Contaminant Data Table below with site-specific information. If no site-specific information is available, use default contaminants provided in Tables 1 or 2 below.

Contaminant Data Table

	Contaminant/Mixture Score	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
1					
2					
3					

Table 1. Contaminant Data Table for Subtitle D (Municipal) Landfills Opened After 1976

	Contaminant/Mixture Score	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
1	Arsenic	3.7	-5	H	H
2	Dichloromethane	3.4	-3.5	H	H
3	Iron	0.5	-1.2	M	H

Table 2. Contaminant Data Table for Subtitle D (Municipal) Landfills Operating Before 1976, and All Subtitle C (Hazardous Waste) Landfills

	Contaminant/Mixture Score	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
1	Arsenic	3.7	-1	H	H
2	Chromium and cyanide	0.8	-3.6	H	H
3	Other metals	1.4	-3.3	M	H

* For additional guidance, especially for contaminant-specific data (SD8), refer to the User's Guide (Chapter 2).

SOURCE WORKSHEET
LANDFILLS

SOURCE # _____

SOURCE WORKSHEET - LANDFILLS

STEP	INSTRUCTIONS	SCORE

LIKELIHOOD OF RELEASE (L_1)

Step 1 Determine the Likelihood of Release (L_1) Score

Use the table below to determine L_1 as a function of Landfill Design (SD1), Landfill Status (SD2), and Landfill Age (SD4).

Likelihood of Release Score by Landfill Design, Landfill Status, and Landfill Age

Landfill Design (SD1)	Landfill Status (SD2) and Landfill Age (SD4)			
	1 Active		2 Post-Closure Care	3 Abandoned or Post-Care
	1-5 years	> 5 years		
1 - Unlined and vegetative cover	0	0	0	0
2 - Clay-lined and synthetic cover	-2.0	-1.7	-0.5	0
3 - Synthetic liner, synthetic cover, and leachate collection system	-0.3	0	0	0
4 - Unlined, and clay and synthetic cover	0	0	0	0
5 - Clay and synthetic liner, clay and synthetic cover, and leachate collection system	*	*	-1.5	0

Likelihood of Release (L_1) Score = ____
(Ref. 59)

SOURCE WORKSHEET - LANDFILLS (continued)

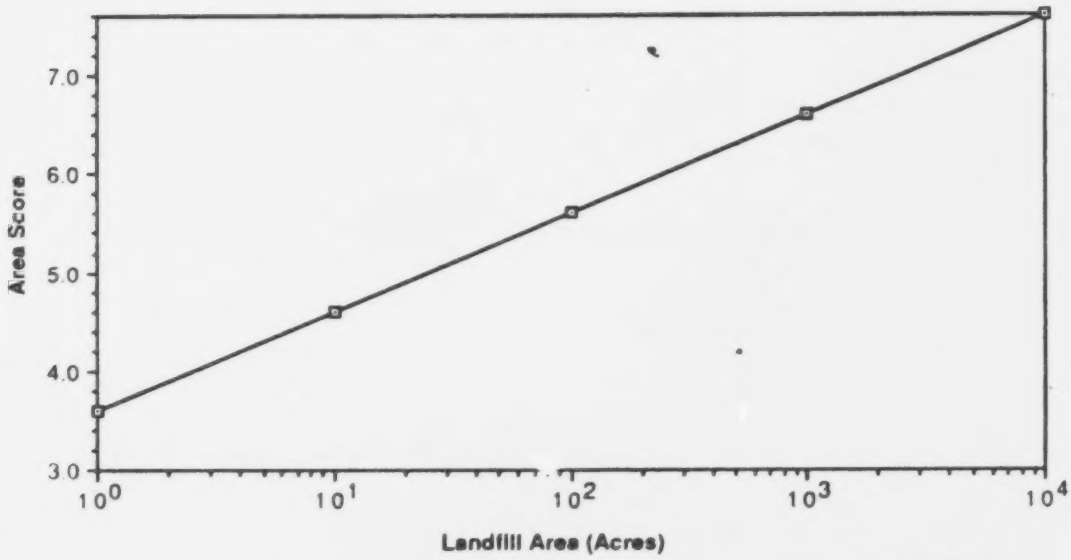
STEP	INSTRUCTIONS	SCORE

QUANTITY (Q)

Step 2 **Determine the Area Score**

Read the Area Score from the following graph as a function of the Landfill Area (SD5).

Area Score by Landfill Area



Area Score: _____

SOURCE WORKSHEET - LANDFILLS (continued)

STEP	INSTRUCTIONS	SCORE

Step 3 Determine the Release Score

You will need the following information:

- the net infiltration parameter that was identified on the Wellhead Datasheet (WD4)
- the landfill design (SD1)
- the landfill status (SD2).

First select the table that corresponds to your landfill status. Then, determine the Release Score based on landfill design and net infiltration. If the table indicates a value of "*," set Release Score, Volume Score (Step 4), and the Quantity Scores (Step 5) all equal to "*."

Release Score by Landfill Status, Landfill Design, and Net Infiltration

Landfill Status = 1 (Active)

Landfill Design (SD1)	Net Infiltration (Inches)			
	0 - 0.6	0.6 - 6	6 - 15	≥ 15
1 and 4	-2.5	-1.7	-1.0	-0.7
2	-4.0	-3.0	-1.5	-1.2
3	*	*	-2.0	-1.6
5	*	*	*	*

Landfill Status = 2 (Post-Closure Care)

Landfill Design (SD1)	Net Infiltration (Inches)			
	0 - 0.6	0.6 - 6	6 - 15	≥ 15
1	-2.2	-1.7	-0.7	-0.3
2	-2.4	-1.9	-1.0	-0.5
3	-2.8	-2.0	-1.4	-1.4
4	-2.5	-1.9	-1.2	-1.0
5	-3.1	-3.1	-1.8	-1.8

SOURCE WORKSHEET - LANDFILLS (continued)

STEP	INSTRUCTIONS	SCORE

Landfill Status = 3 (Abandoned or Post-Care)

Landfill Design (SD1)	Net Infiltration (Inches)			
	0 - 0.6	0.6 - 6	6 - 15	≥ 15
All Designs	-2.2	-1.7	-0.7	-0.3

Release Score: _____
(Ref. 59)

Step 4 Compute the Volume Score

Volume Score = Area Score (Step 2)
+ Release Score (Step 3)

(Note: If Release Score is "*," then enter a Volume Score of "*.")

Volume Score: _____

Step 5 Compute the Quantity Score (Q) for Each Contaminant

Quantity Score (Q) = Volume Score (Step 4)
+ Concentration Score (SD8)

(Note: If Volume Score is "*," then enter a Quantity Score (Q) of "*" for all contaminants.)

	Contaminant or Contaminant Mixture	Concentration Score (SD8)		Volume Score	Quantity Score (Q)
(1)	_____	_____	+	_____	_____
(2)	_____	_____	+	_____	_____
(3)	_____	_____	+	_____	_____

SOURCE DATASHEET - MATERIAL TRANSPORT

Step 5

Source #: _____ Author: _____

Source Name: _____ Date: _____

Location: _____

PARAMETER	INSTRUCTIONS*	VALUE
DESIGN PARAMETERS		
SD1 Road Density	Enter Low, Medium, or High for the density of roads within the WHPA that are used to transport hazardous materials where: Low = 1 - 10 miles of roads Medium = 11 - 100 miles High = > 100 miles	_____
SD2 Frequency of Shipments	Enter Low, Medium, or High for the frequency of hazardous material shipments per year where: Low = 1 -10 shipments/year Medium = 11 - 100 shipments/year High = > 100 shipments/year If you do not know the number of shipments per year, use the following: Low = WHPA is in a non-urban area* and is not intersected by an interstate Medium = WHPA is in a non-urban area and is intersected by an interstate, or is in an urban area and is not intersected by an interstate High = WHPA is in an urban area and is intersected by an interstate. * Note. an urban area is defined as a central city or central core that has a population of at least 50,000 people.	_____

Material Transport

* For additional guidance, especially for contaminant-specific data (SD6), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - MATERIAL TRANSPORT (continued)

PARAMETER	INSTRUCTIONS*	VALUE
SD3 Age	Enter the estimated number of years that hazardous materials have been transported through the WHPA.	_____ years
HYDROGEOLOGIC SETTINGS		
SD4 Distance Score	Use the table below to determine the Distance Score as a function of the distance from the source to the well (or to an abandoned well if one exists between the source and the well). Use the distance between the wellhead and the section of road (used to transport hazardous materials) that is nearest to the wellhead.	_____

Distance Scoring Form

Distance from Source to Well							
	(Miles)	0 - .12	.12 - .25	.25 -.5	.5 - 1.0	1.0 - 3.0	3.0 - 5.0
	(Feet)	0 - 635	635 - 1320	1320 - 2640	2640 - 5280	5280 - 15,840	15,840 - 26,400
	(Meters)	0 - 193	193-402	402 - 805	805 - 1610	1610 - 4829	4829 - 8040
Distance Score		1	2	3	4	5	6

SD5 Does the source discharge directly to a conduit system (e.g., pipes or utility chase) that could transport contaminants directly to the well?	Yes or No	_____

* For additional guidance, especially for contaminant-specific data (SD6), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - MATERIAL TRANSPORT (continued)

PARAMETER	INSTRUCTIONS*	VALUE

CONTAMINANT PARAMETERS

SD6 Contaminant Data

Use Contaminant Forms S.1 or S.2 to complete the Contaminant Data Table below. Refer to Task 2 of the User's Guide for additional guidance.

Contaminant Data Table

	Contaminant/Mixture Score	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
1					
2					
3					

* For additional guidance, especially for contaminant-specific data (SD6), refer to the User's Guide (Chapter 2).

SOURCE WORKSHEET
MATERIAL TRANSPORT

SOURCE # _____

SOURCE WORKSHEET - MATERIAL TRANSPORT

STEP	INSTRUCTIONS	SCORE

LIKELIHOOD OF RELEASE (L_1)

Step 1 Determine the Likelihood of Release (L_1) Score

Read L_1 from the table below as a function of Road Density (SD1) and Frequency of Shipments (SD2).

Likelihood of Release Score by Frequency of Shipments and Road Density

Frequency of Shipments	Road Density		
	Low	Medium	High
Low	-5.0	-4.0	-3.0
Medium	-4.0	-3.0	-2.0
High	-3.0	-2.0	-1.0

Likelihood of Release (L_1) Score = ____
(Ref. 20)

SOURCE WORKSHEET - MATERIAL TRANSPORT (continued)

STEP	INSTRUCTIONS	SCORE
QUANTITY (Q)		
Step 2	**Compute the Quantity Score (Q) for Each Contaminant**	

For each contaminant that is transported within the WHPA, determine a separate Quantity Score as a function of the Contaminant Concentration Score and a constant Release Score of 1.1 (Ref. 20).

Quantity Score (Q) = Concentration Score (SD6) + 1.1

Contaminant or Contaminant Mixture	Quantity Score (Q)
(1) _____	_____
(2) _____	_____
(3) _____	_____

SOURCE DATASHEET - PIPELINES

Step 5

Source #: _____ Author: _____

Source Name: _____ Date: _____

Location: _____

PARAMETER	INSTRUCTIONS*	VALUE
DESIGN PARAMETERS		
SD1 Pipeline Type	Choose one of the following types of pipelines: Sewer or Other (includes Petroleum).	_____
SD2 Age of Pipeline	Enter the age of the pipeline system.	_____ years
SD3 Annual Throughput	Obtain values for throughput from sewage treatment plant or pipeline company officials. If the total annual sewage throughput through the WHPA is unknown, assume an annual throughput per person of 27,375 gallons. If the sewage treatment plant is located within the WHPA, multiply this value by the city population to determine the Annual Throughput. Otherwise, multiply this value by the number of people living in the WHPA to determine the Annual Throughput.	_____ million gallons/year (Ref. 8)
SD4 Pipeline Length	Indicate the length, in miles, of pipeline within the WHPA for Other (Petroleum) pipelines only.	_____ miles

Pipelines

* For additional guidance, especially for contaminant-specific data (SD7), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - PIPELINES (continued)

PARAMETER	INSTRUCTIONS*	VALUE
HYDROGEOLOGIC SETTINGS		
SD5 Distance Score	Use the table below to determine the Distance Score as a function of the shortest distance from the pipeline to the well (or to an abandoned well if one exists between the source and the well). For example, if the shortest distance between the pipeline and the well is 1,000 feet, then the Distance Score is equal to 2.	_____

Distance Scoring Form

Distance from Source to Well	(Miles)	0 - .12	.12 - .25	.25 - .5	.5 - 1.0	1.0 - 3.0	3.0 - 5.0
	(Feet)	0 - 635	635 - 1320	1320 - 2640	2640 - 5280	5280 - 15,840	15,840 - 26,400
	(Meters)	0 - 193	193-402	402 - 805	805 - 1610	1610 - 4829	4829 - 8040
Distance Score		1	2	3	4	5	6

SD6 Does the source discharge directly to a conduit system (e.g., pipes or utility chase) that could transport contaminants directly to the well?	Yes or No	_____

* For additional guidance, especially for contaminant-specific data (SD7), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - PIPELINES (continued)

PARAMETER	INSTRUCTIONS*	VALUE

CONTAMINANT PARAMETERS

SD7 Contaminant Data

Use Contaminant Forms S.1 or S.2 to complete the Contaminant Data Table below. Refer to Task 2 of the User's Guide for additional guidance.

Contaminant Data Table

	Contaminant/Mixture Score	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
1					
2					
3					

* For additional guidance, especially for contaminant-specific data (SD7), refer to the User's Guide (Chapter 2).

SOURCE WORKSHEET
PIPELINES

SOURCE # _____

SOURCE WORKSHEET - PIPELINES

STEP	INSTRUCTIONS	SCORE

LIKELIHOOD OF RELEASE (L_1)

Step 1 Determine the Likelihood of Release (L_1) Score

For Sewer Pipelines, set $L_1 = 0$.

For Other Pipelines (e.g., petroleum), use the table below to determine the Likelihood of Release Score as a function of the Pipeline Length (SD4) and the Age of Pipeline (SD2).

Likelihood of Release Scores for Other (e.g., Petroleum) Pipelines by Age and Pipeline Length

Pipeline Length (Miles)	Age (Years)		
	< 10	10 - 20	> 20
1 - 10	-0.6	-0.3	0.0
11 - 20	-0.3	0.0	0.0
> 20	0.0	0.0	0.0

Likelihood of Release (L_1) Score = ____
(Ref. 39)

SOURCE WORKSHEET - PIPELINES (continued)

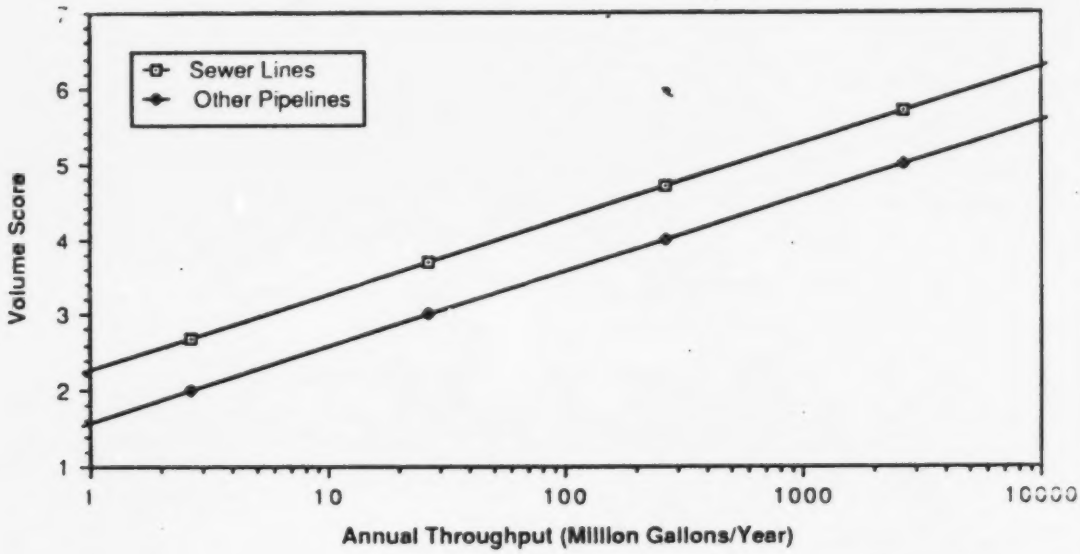
STEP	INSTRUCTIONS	SCORE

QUANTITY (Q)

Step 2 **Determine the Volume Score (Q)**

Use the graph below to determine the Volume Score as a function of Pipeline Type (SD1) and Annual Throughput (SD3).

Volume Score by Annual Throughput and Pipeline Type



Volume Score: _____
(Ref. 26)

Step 3 **Compute the Quantity Score**

Quantity Score (Q) = Concentration Score (SD7) + Volume Score (Step 2)

Contaminant or Contaminant Mixture	Quantity Score (Q)
(1) _____	_____
(2) _____	_____
(3) _____	_____

SOURCE DATASHEET - SEPTIC TANK SYSTEMS

Step 5

Source #: _____ Author: _____

Source Name: _____ Date: _____

Location: _____

PARAMETER	INSTRUCTIONS*	VALUE
DESIGN PARAMETERS		
SD1 Septic System Age	Estimate the average age of the septic systems in question	_____ years
SD2 Total Sewage Throughput	See Note below.	_____ thousand gallons/year (ref. 37)

Annual Sewage Throughput by Number and Type of Units Using Septic Systems (Thousands of Gallons per Year)

Septic System Type	Number of Units**				
	1-20	21-50	51-150	151-500	501 +
Houses	1,095	3,504	10,950	35,040	109,500
Apartments	438	1,402	4,380	10,402	43,800
Small Businesses	241	771	2,409	7,709	24,090

** For houses, the number of units is the number of houses.
For apartments, the number of units is the number of individual apartments.
For small businesses, the number of units is the number of individual small retailers such as gift and novelty stores and sporting goods stores.

Septic Tank Systems

Note: Use the table above to calculate the Total Sewage Throughput as a function of the number and type (house, apartment, or small business) of units using septic systems. For apartments, the number of units is the number of individual apartments using septic systems. For small businesses, include retailers whose throughput would include sanitary wastes only, such as gift and novelty stores and sporting goods stores. For example, if there is a cluster of about 25 houses, 60 apartments, and 20 small businesses that use septic systems, then the Total Sewage Throughput would equal 3,504 + 4,380 + 241, i.e., 8,125 thousand gallons/year.

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - SEPTIC TANK SYSTEMS (continued)

PARAMETER	INSTRUCTIONS*	VALUE
HYDROGEOLOGIC SETTINGS		
SD3 Distance Score	Use the table below to determine the Distance Score as a function of the distance from the source to the well (or to an abandoned well if one exists between the source and the well). Use the shortest distance from any one unit using a septic system to the well. For example, if the shortest distance between any one unit using a septic system and the well is 1,000 feet, then the Distance Score is equal to 2.	_____

Distance Scoring Form

Distance from Source to Well	(Miles)	0 - .12	.12 - .25	.25 - .5	.5 - 1.0	1.0 - 3.0	3.0 - 5.0
	(Feet)	0 - 635	635 - 1320	1320 - 2640	2640 - 5280	5280 - 15,840	15,840 - 26,400
	(Meters)	0 - 193	193-402	402 - 805	805 - 1610	1610 - 4829	4829 - 8040
Distance Score		1	2	3	4	5	6

SD4 Does the source discharge directly to a conduit system (e.g., pipes or utility chase) that could transport contaminants directly to the well?	Yes or No	_____

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - SEPTIC TANK SYSTEMS (continued)

PARAMETER	INSTRUCTIONS*	VALUE

CONTAMINANT PARAMETERS

SD5 Contaminant Data

Use Contaminant Forms S.1 or S.2 to complete the Contaminant Data Table below. Refer to Task 2 of the User's Guide for additional guidance.

Contaminant Data Table

	Contaminant/Mixture Score	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
1					
2					
3					

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide (Chapter 2).

SOURCE WORKSHEET
SEPTIC TANK SYSTEMS

Step 6

SOURCE # _____

SOURCE WORKSHEET - SEPTIC TANK SYSTEMS

STEP	INSTRUCTIONS	SCORE

LIKELIHOOD OF RELEASE (L_1)

Step 1 Likelihood of Release (L_1) Score

Set $L_1 = 0$.

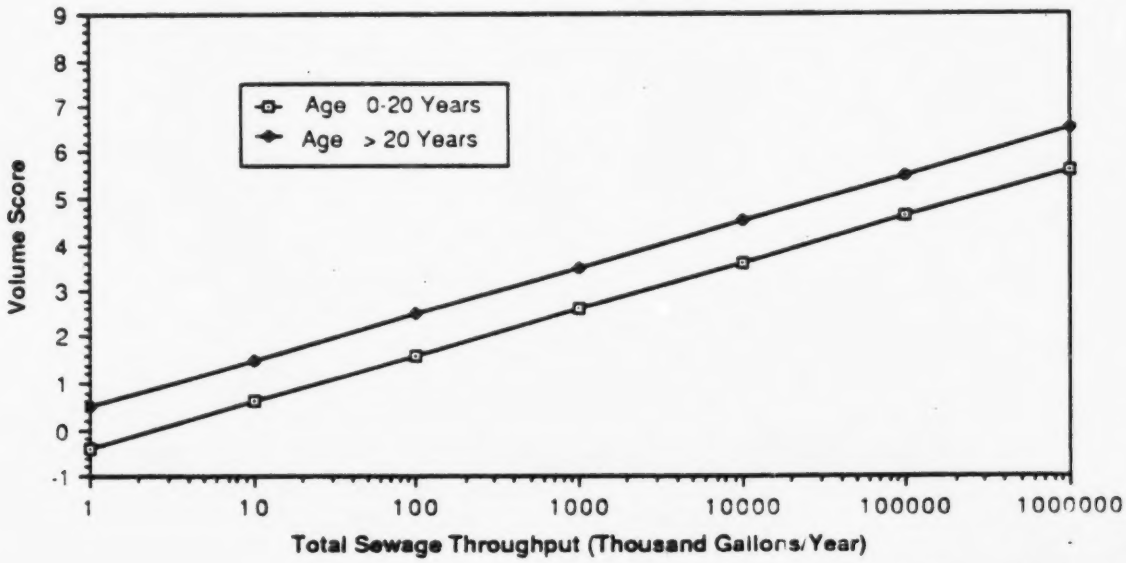
Likelihood of Release (L_1) Score = 0

QUANTITY (Q)

Step 2 Determine the Volume Score

Use the graph below to determine the Volume Score as a function of the Total Sewage Throughput (SD2) and the Septic System Age (SD1).

Volume Score by Total Sewage Throughput and Septic System Age



Volume Score: _____

(Ref. 26)

SOURCE WORKSHEET - SEPTIC TANK SYSTEMS (continued)

STEP	INSTRUCTIONS	SCORE
Step 3	**Compute the Quantity Score (Q) for Each Contaminant**	

Quantity Score (Q) = Volume Score (Step 2)
+ Concentration Score (SD5)

Contaminant or Contaminant Mixture	Quantity Score (Q)
(1) _____	_____
(2) _____	_____
(3) _____	_____

SOURCE DATASHEET - STORAGE PILES

Step 5

Source: _____ Author: _____

Source Name: _____ Date: _____

Location: _____

PARAMETER	INSTRUCTIONS*	VALUE
DESIGN PARAMETERS		
SD1 Storage Pile Type	Circle the appropriate storage pile type: "Non-Heap Leaching" or "Heap Leaching." "Heap-Leaching" storage piles are associated with metals mining. All other storage piles are "Non-Heap Leaching."	Non-Heap Leaching Heap Leaching
SD2 Storage Pile Design	Enter 1, 2, or 3 for the Storage Pile Design, where: 1 = No liner or pile 2 = Clay, concrete, or asphalt pad 3 = Single synthetic liner with leachate collection system.	_____
SD3 Storage Pile Area	Estimate the area of the Storage Pile, in acres.	_____ acres
SD4 Storage Pile Age	Indicate the age of the Storage Pile.	_____ years

Storage Piles

* For additional guidance, especially for contaminant-specific data (SD7), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - STORAGE PILES (continued)

PARAMETER	INSTRUCTIONS*	VALUE
HYDROGEOLOGIC SETTINGS		
SD5 Distance Score	Use the table below to determine the Distance Score as a function of the shortest distance from the storage pile to the well (or to an abandoned well if one exists between the storage pile and the well). For example, if the shortest distance between the storage pile and the well is between 1/4 and 1/2 mile, then the Distance Score is equal to 3.	_____

Distance Scoring Form

Distance from Source to Well	(Miles)	0 - .12	.12 - .25	.25 - 5	.5 - 1.0	1.0 - 3.0	3.0 - 5.0
	(Feet)	0 - 635	635 - 1320	1320 - 2640	2640 - 5280	5280 - 15,840	15,840 - 26,400
	(Meters)	0 - 193	193-402	402 - 805	805 - 1610	1610 - 4829	4829 - 8040
Distance Score		1	2	3	4	5	6

SD6 Does the source discharge directly to a conduit system (e.g., pipes or utility chase) that could transport contaminants directly to the well?	Yes or No	_____

* For additional guidance, especially for contaminant-specific data (SD7), refer to the User's Guide. (Chapter 2).

SOURCE DATASHEET - STORAGE PILES (continued)

PARAMETER	INSTRUCTIONS*	VALUE
CONTAMINANT PARAMETERS		
SD7 Contaminant Data	Use Contaminant Forms S.1 or S.2 to complete the Contaminant Data Table below. Refer to Task 2 of the User's Guide for additional guidance.	

Contaminant Data Table

	Contaminant/Mixture Score	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
1					
2					
3					

* For additional guidance, especially for contaminant-specific data (SD7), refer to the User's Guide. (Chapter 2).

SOURCE WORKSHEET
STORAGE PILES

SOURCE # _____

SOURCE WORKSHEET - STORAGE PILES

STEP	INSTRUCTIONS	SCORE

LIKELIHOOD OF RELEASE (L_1)

Step 1 Determine the Likelihood of Release (L_1) Score

Use the table below to determine the Likelihood of Release Score (L_1) as a function of Storage Pile Design (SD2). The Likelihood of Release Score accounts for failure of the pad or synthetic liner.

Design No.	Likelihood of Release Score
1 -- No Liner or Pad	0
2 -- Clay, Concrete, or Asphalt Pad	-1.0
3 -- Single Synthetic Liner with Leachate Collection System (LCS)	-2.0

Likelihood of Release (L_1) Score = _____
(Refs. 5, 16, and 59)

SOURCE WORKSHEET - STORAGE PILES (continued)

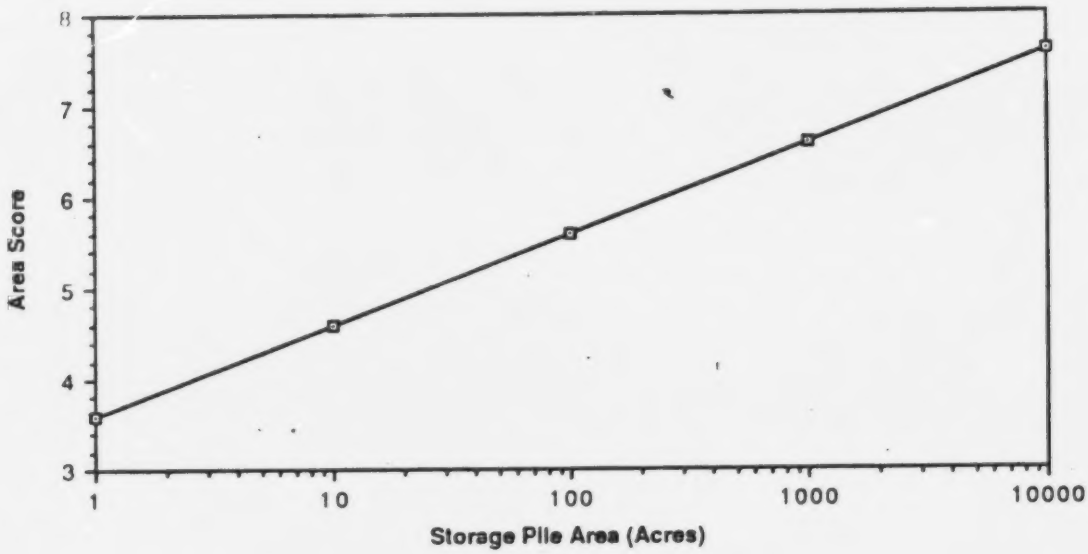
STEP	INSTRUCTIONS	SCORE

QUANTITY (Q)

Step 2 **Determine the Area Score**

Use the graph below to determine the Area Score as a function of Storage Pile Area (SD3).

Area Score by Storage Pile Area



Area Score: _____

SOURCE WORKSHEET - STORAGE PILES (continued)

STEP	INSTRUCTIONS	SCORE

Step 3 Determine the Release Score

Depending on the Storage Pile Type (SD1), use one of the two tables below to determine the Release Score. If the Storage Pile is Non-Heap Leaching, then use the table below to determine the Release Score based on the Storage Pile Design (SD2) and the net infiltration rate determined in the Wellhead Datasheet (WD4).

Non-Heap Leaching Storage Pile Release Score by Storage Pile Design and Net Infiltration

Storage Pile Design (SD2)	Net Infiltration (Inches)			
	0 - 0.6	0.6 - 6	6 - 15	> 15
1	-2.2	-1.6	-0.6	-0.3
2	-2.7	-2.1	-1.1	-0.7
3	-3.2	-2.6	-1.6	-1.3

(Refs. 19 and 59)

If the storage pile is Heap-Leaching, then use the table below to determine the Release Score based on the Storage Pile Design (SD2).

Heap-Leaching Storage Pile Release Score by Storage Pile Design

Storage Pile Design	Release Score
1 -- No Liner or Pad	-0.1
2 -- Clay, Concrete, or Asphalt Pad	-0.5
3 -- Single Synthetic Liner with LCS	-1.2

(Refs. 19, 35, and 59)

SOURCE WORKSHEET - STORAGE PILES (continued)

STEP	INSTRUCTIONS	SCORE

Step 4 Determine the Volume Score

Volume Score = Area Score (Step 2)
+ Release Score (Step 3)

Volume Score: _____

Step 5 Compute the Quantity Score (Q) for Each Contaminant

Quantity Score (Q) = Concentration
Score (SD7) + Volume Score (Step 3)

Contaminant or Contaminant Mixture	Quantity Score (Q)
(1) _____	_____
(2) _____	_____
(3) _____	_____

SOURCE DATASHEET - SURFACE IMPOUNDMENTS

Step 5

Source #: _____ Author: _____

Source Name: _____ Date: _____

Location: _____

PARAMETER	INSTRUCTIONS*	VALUE
DESIGN PARAMETERS		
SD1 Surface Impoundment Design	Enter 1, 2, or 3 for the design of the Surface Impoundment, where: 1 = No liner 2 = Clay liner 3 = Clay and synthetic liner	_____ (Ref. 41)
SD2 Surface Impoundment Area	Estimate the area of the Surface Impoundment, in acres.	_____ acres
SD3 Surface Impoundment Age	Indicate the age of the impoundment.	_____ years

* For additional guidance, especially for contaminant-specific data (SD6), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - SURFACE IMPOUNDMENT (continued)

PARAMETER	INSTRUCTIONS*	VALUE

HYDROGEOLOGIC SETTINGS

SD4 Distance Score

Use the table below to determine the Distance Score as a function of the shortest distance from the surface impoundment to the well (or to an abandoned well if one exists between the surface impoundment and the well). For example, if the shortest distance between the surface impoundment and the well is between 1/2 and 1 mile, then the Distance Score is equal to 4.

_____

Distance Scoring Form

Distance from Source to Well	(Miles)	0 - .12	.12 - .25	.25 - 5	.5 - 1.0	1.0 - 3.0	3.0 - 5.0
	(Feet)	0 - 635	635 - 1320	1320 - 2640	2640 - 5280	5280 - 15,840	15,840 - 26,400
	(Meters)	0 - 193	193-402	402 - 805	805 - 1610	1610 - 4829	4829 - 8040
Distance Score		1	2	3	4	5	6

SD5 Does the source discharge directly to a conduit system (e.g., pipes or utility chase) that could transport contaminants directly to the well?

Yes or No

_____

* For additional guidance, especially for contaminant-specific data (SD6), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - SURFACE IMPOUNDMENT (continued)

PARAMETER	INSTRUCTIONS*	VALUE

CONTAMINANT PARAMETERS

SD6 Contaminant Data

Use Contaminant Forms S.1 or S.2 to complete the Contaminant Data Table below. Refer to Task 2 of the User's Guide for additional guidance.

Contaminant Data Table

	Contaminant/Mixture Score	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
1					
2					
3					

* For additional guidance, especially for contaminant-specific data (SD6), refer to the User's Guide (Chapter 2).

SOURCE WORKSHEET
SURFACE IMPOUNDMENTS

Step 6

SOURCE # _____

SOURCE WORKSHEET - SURFACE IMPOUNDMENTS

STEP	INSTRUCTIONS	SCORE

LIKELIHOOD OF RELEASE (L_1)

Step 1 Determine the Likelihood of Release (L_1) Score

Use the table below to determine the Likelihood of Release Score (L_1) as a function of Impoundment Design (SD1). The Likelihood of Release Score accounts for liner failure over a twenty-year active life.

Design No.	Likelihood of Release Score
1 – No Liner	0
2 – Clay Liner	0
3 – Clay and Synthetic Liner	-1.5

Likelihood of Release (L_1) Score = _____
(Ref. 59)

SOURCE WORKSHEET - SURFACE IMPOUNDMENTS (continued)

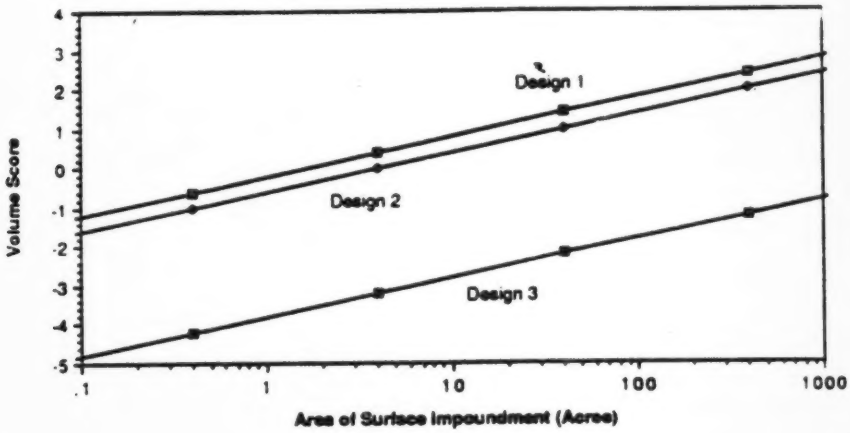
STEP	INSTRUCTIONS	SCORE

QUANTITY (Q)

Step 2 Compute the Volume Score

Use the graph below to determine the Volume Score as a function of Surface Impoundment Area (SD2).

Volume Score by Surface Impoundment Area



Volume Score: _____
(Refs. 19 and 59)

Step 3 Compute the Quantity Score (Q) for Each Contaminant

Quantity Score (Q) = Concentration Score (SD6) + Volume Score (Step 2)

Contaminant or Contaminant Mixture	Quantity Score (Q)
(1) _____	_____
(2) _____	_____
(3) _____	_____

SOURCE DATASHEET - TANKS

Step 5

Source _____ Author: _____

Source Name: _____ Date: _____

Location: _____.

PARAMETER	INSTRUCTIONS*	VALUE
DESIGN PARAMETERS		
SD1 Number of Tanks	You may want to group tanks containing similar contaminants and of similar size, design, age and distance from the wellhead. You need not determine the exact number of tanks; rather, determine if the number of tanks is within one of the following ranges: 1, 2-5, 6-25, 26-75, or > 75.	_____
SD2 Tank Size	Enter Small, Medium, or Large for the size of each tank or group. Small = < 5,000 gallons each Medium = 5,000 - 30,000 gallons each Large = > 30,000 gallons each	_____
SD3 Tank Design	Enter the tank number using the information in the table on the next page (Refs. 12 and 25).	_____

* For additional guidance, especially for contaminant-specific data (SD7), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - TANKS (continued)

PARAMETER	INSTRUCTIONS*	VALUE

Tank Design

Design	Description
A.	**Hazardous Waste, Chemical, and Petroleum Storage Tanks**
1	Above-ground bare steel tank resting on cradles on a concrete pad with curbing. The tank capacity is less than or equal to 30,000 gallons (small or medium).
2	Above-ground bare steel tank resting on-grade on a concrete pad with curbing. The tank capacity is greater than or equal to 30,000 gallons (large).
3	In-ground concrete tank with an open top at ground level.
4	Below-ground bare steel tank.
5	Below-ground double-walled steel tank with interstitial monitoring.
6	Below-ground $STiP_3$ tank (cathodically protected).
7	Below-ground fiber-reinforced plastic (FRP) tank.
B.	**Hazardous Waste and Wastewater Treatment Tanks**
8	Above-ground bare steel tank resting on cradles on a concrete pad with curbing. The tank capacity is less than or equal to 30,000 gallons (small or medium).
9	Above-ground bare steel tank resting on-grade on a concrete pad with curbing. The tank capacity is greater than or equal to 30,000 gallons (large).
10	In-ground concrete tank with an open top at ground level.
C.	**Hazardous Waste Small Quantity Generator and Farm Storage Tanks**
11	Above-ground bare steel tank resting on cradles.
12	Below-ground bare steel tank.

* For additional guidance, especially for contaminant-specific data (SD7), refer to the User's Guide (Chapter 2).

SOURCE DATASHEET - TANKS (continued)

PARAMETER	INSTRUCTIONS*	VALUE
SD4 Tank Age	Enter the age of the tank or the average age of the tanks in the group.	_____ year(s)
HYDROGEOLOGIC SETTINGS		
SD5 Distance Score	Use the table below to determine the Distance Score as a function of the shortest distance from the tank(s) to the well (or to the abandoned well if one exists between the tank(s) and the well). For example, if the shortest distance between the tank(s) and the well is between 1/2 and 1 mile, then the Distance Score is equal to 4.	-----

Distance Scoring Form

Distance from Source to Well							
	(Miles)	0 - .12	.12 - .25	.25 - .5	.5 - 1.0	1.0 - 3.0	3.0 - 5.0
	(Feet)	0 - 635	635 - 1320	1320 - 2640	2640 - 5280	5280 - 15,840	15,840 - 26,400
	(Meters)	0 - 193	193-402	402 - 805	805 - 1610	1610 - 4829	4829 - 8040
Distance Score		1	2	3	4	5	6

SD6 Does the source discharge directly to a conduit system (e.g., pipes or utility chase) that could transport contaminants directly to the well?	Yes or No	_____

* For additional guidance, especially for contaminant-specific data (SD7), refer to the User's Guide. (Chapter 2).

SOURCE DATASHEET - TANKS (continued)

PARAMETER	INSTRUCTIONS*	VALUE

CONTAMINANT PARAMETERS

SD7 Contaminant Data

Use Contaminant Forms S.1 or S.2 to complete the Contaminant Data Table below. Refer to Task 2 of the User's Guide for additional guidance.

Contaminant Data Table

	Contaminant/Mixture Score	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
1					
2					
3					

* For additional guidance, especially for contaminant-specific data (SD5), refer to the User's Guide. (Chapter 2).

SOURCE WORKSHEET
TANKS

SOURCE # _____

SOURCE WORKSHEET - TANKS

STEP	INSTRUCTIONS	SCORE

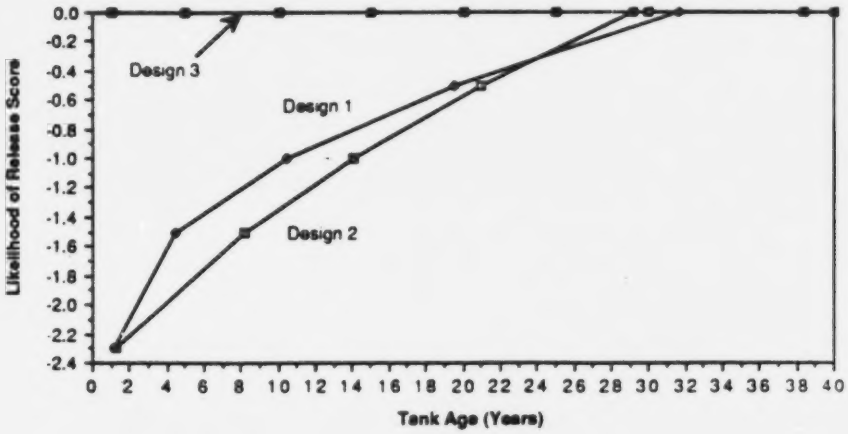
LIKELIHOOD OF RELEASE (L_1)

Step 1 Likelihood of Release (L_1) Score

Use the graphs on the next page to determine the Likelihood of Release Score (L_1) as a function of Tank Design (SD3) and Tank Age (SD4). For Designs 1-3, use the first graph; for Designs 4-7, use the second graph; for Designs 8-10, use the third graph; and for Designs 11-12, use the fourth graph. Note that if your Tank Design is 3 or 10, $L_1 = 0$. If Tank Age is greater than 40 years, set the Likelihood of Release Score to 0.

Likelihood of Release (L_1) Score = _____
(Ref. 25)

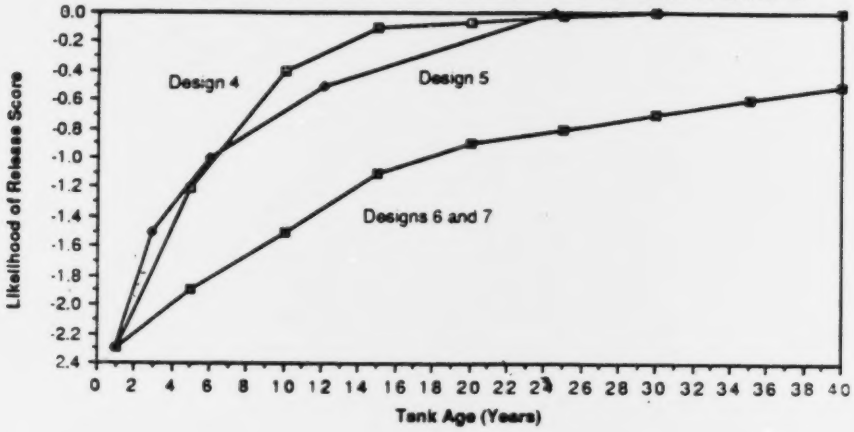
GRAPH 1: DESIGNS 1 - 3
LIKELIHOOD OF RELEASE SCORE FOR ABOVE-GROUND AND IN-GROUND STORAGE TANKS



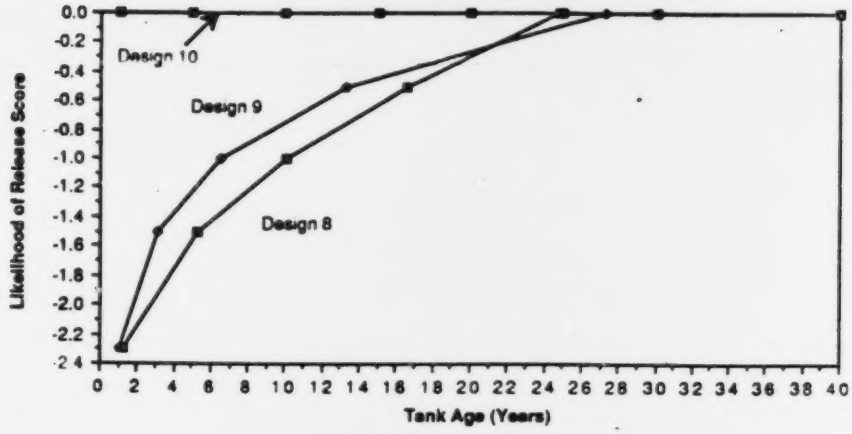
SOURCE WORKSHEET - TANKS (continued)

STEP	INSTRUCTIONS	SCORE

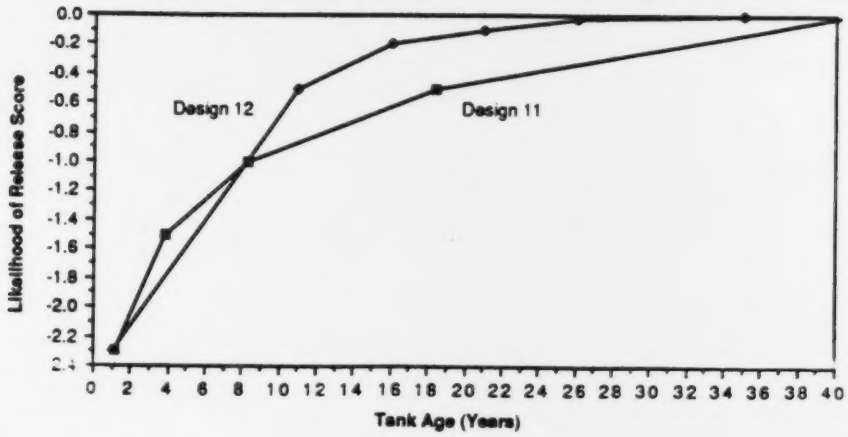
GRAPH 2: DESIGNS 4 - 7
LIKELIHOOD OF RELEASE SCORE FOR BELOW-GROUND STORAGE TANKS



GRAPH 3: DESIGNS 8 - 10
LIKELIHOOD OF RELEASE SCORE FOR TREATMENT TANKS



GRAPH 4: DESIGNS 11 - 12
LIKELIHOOD OF RELEASE SCORE FOR SQG AND FARM STORAGE TANKS



SOURCE WORKSHEET - TANKS (continued)

STEP	INSTRUCTIONS	SCORE

QUANTITY (Q)

Step 2 Compute the Volume Score

Use the graph below to determine the Volume Score as a function of the Number of Tanks (SD1), Tank Size (SD2), and Tank Design (SD3).

Volume Score for Storage and Treatment Tanks

Tank Design	Number of Tanks														
	1			2 - 5			6 - 25			26 - 75			>75		
	Tank Size			Tank Size			Tank Size			Tank Size			Tank Size		
	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L
1	-0.2	-0.1	-	0.2	0.3	-	1.4	1.5	-	1.9	2	-	2.2	2.3	-
2	-	-	0.9	-	-	1.3	-	-	2.5	-	-	3	-	-	3.3
3	-0.7	-0.6	-0.4	-0.2	-0.1	0.1	1	1.1	1.3	1.5	1.6	1.8	1.8	1.9	2.1
4	0.3	0.4	-	0.7	0.8	-	1.9	2	-	2.4	2.5	-	2.7	2.8	-
5	-1.2	-1	-	-0.7	-0.5	-	0.5	0.7	-	1	1.2	-	1.3	1.5	-
6	0.9	1	-	1.4	1.5	-	2.6	2.7	-	3.1	3.2	-	3.4	3.5	-
7	0.4	0.5	0.6	0.9	1	1.1	2.1	2.2	2.3	2.6	2.7	2.8	2.9	3	3.1
8	-1	-0.8	-	-0.5	-0.3	-	0.7	0.9	-	1.2	1.4	-	1.5	1.7	-
9	-	-	0.2	-	-	0.7	-	-	1.9	-	-	2.4	-	-	2.7
10	-0.1	-0.1	0.1	0.3	-0.3	0.5	1.5	1.5	1.7	2	2	2.2	2.3	2.3	2.5
11	-0.7	-	-	-0.3	-	-	0.9	-	-	1.4	-	-	1.7	-	-
12	-1.3	-	-	-0.9	-	-	0.9	-	-	0.8	-	-	1.1	-	-

– Indicates not applicable

S = Small, M = Medium, L = Large

Volume Score: _____
(Ref. 25)

SOURCE WORKSHEET - TANKS (continued)

STEP	INSTRUCTIONS	SCORE

Step 3 Compute the Quantity Score (Q) for Each Contaminant

Quantity Score (Q) = Concentration Score (SD7)
+ Volume Score (Step 2)

Contaminant or Contaminant Mixture	Quantity Score (Q)
(1) _____	_____
(2) _____	_____
(3) _____	_____

SOURCE # _____

TRANSPORT WORKSHEET*

STEP	INSTRUCTIONS	SCORE

This worksheet* provides guidance for determining scores for each step in the transport calculations. In this guidance, the labels in parentheses refer to three sources of scores:

- scores from a step in the Wellhead Datasheet, e.g., (WD2)
- scores from the Source Datasheet, i.e., (SD)
- scores from a step in this Transport Worksheet, e.g., (Step 5).

Step 1 Compute Timeframe

Timeframe (years) = Age of Source (SD)
+ Planning Period (WD1)

Timeframe = _____

CONTAMINANT-SPECIFIC STEPS

Steps 2 through 8 will help you calculate two risk elements for each contaminant or contaminant/mixture at the source: Likelihood of Reaching the Well (L_2) and Attenuation Due to Transport (A). For a given source, L_2 and A vary only with the contaminant's mobility and persistence. Therefore, you need only recompute L_2 and A by completing Steps 2 through 8 for contaminants with different values of mobility and/or persistence.

Step 2 Determine Hydraulic Conductivity and Velocity Scores

Use the following table to determine the Hydraulic Conductivity and Velocity Scores as a function of the Contaminant Mobility (SD) and either the Unsaturated Zone Hydraulic Conductivity score (WD5) or the Ground-Water Velocity score (WD7), respectively. For example, if Contaminant Mobility is Medium and the Unsaturated Zone Hydraulic Conductivity score is 4, then the Hydraulic Conductivity Score is equal to 3.

---

* References 17, 43, 57, and 73 were used to develop this worksheet.

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Adjusted Hydraulic Conductivity and Velocity Scores

Unsaturated Zone Hydraulic Conductivity Score or Ground-Water Velocity Score	Contaminant Mobility		
	L	M	H
1	1	1	1
2	1	1	2
3	1	2	3
4	2	3	4
5	3	4	5

CONTAMINANT

	1	2	3
Hydraulic Conductivity Score =	____	____	____
Velocity Score =	____	____	____

Quick Exit

If the source discharges directly to a conduit system that could transport contaminants directly to the well (SD), then for each contaminant at the source:

Skip Steps 3 and 4, set the Likelihood of Reaching the Well (L_2) in Step 5 equal to 0, and go to Step 6.

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Step 3 Determine Unsaturated Zone and Saturated Zone Time of Travel (TOT) Categories

Use the following table to determine the Unsaturated Zone TOT Category as a function of the Depth to Aquifer score (WD2) and the Hydraulic Conductivity score (Step 2). For example, if the Depth to Aquifer score is 1.5 and the Hydraulic Conductivity Score is 2, then the Unsaturated Zone TOT Category is D.

Unsaturated Zone Time of Travel Category

Depth to Aquifer Score	Hydraulic Conductivity Score				
	1	2	3	4	5
0.3	E	B	A	A	A
1	F	C	A	A	A
1.5	F	D	B	A	A
2.2	F	D	B	A	A

CONTAMINANT

1 2 3

Unsaturated Zone TOT Category = ____ ____ ____

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE
	Likewise, use the following table to determine the Saturated Zone TOT Category as a function of the Distance score (SD) and Velocity Score (Step 2).	

Saturated Zone Time of Travel Categories

Distance Score	Velocity Score			
	2	3	4	5
1	D	B	A	A
2	D	B	A	A
3	E	B	A	A
4	F	C	A	A
5	F	C	A	A
6	F	C	A	A

Note: If the Velocity Score is 1, then the Saturated Zone Time of Travel Category is Equal to F

CONTAMINANT

1 2 3

Saturated Zone TOT Category = ____ ____ ____

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Step 4 Determine Unsaturated Zone and Saturated Zone Likelihoods (L_U) and (L_S)

Use the following table to find the Unsaturated Zone Likelihood (L_U) as a function of the Unsaturated Zone TOT Category (Step 3) and Timeframe (Step 1).

Unsaturated and Saturated Zone Likelihood Scores (L_U and L_S)

Time of Travel Category	Timeframe (Years)			
	1-10	11-100	101-500	501-1000
A	0	0	0	0
B	-0.3	0	0	0
C	-3	-0.3	-0.1	0
D	-100	-0.9	-0.3	-0.1
E	-100	-100	-0.3	-0.3
F	-100	-100	-100	-100

CONTAMINANT

1 2 3

Unsaturated Zone Likelihood (L_U) = ____ ____ ____

Use the same table to determine the Saturated Zone Likelihood (L_S) as a function of the Saturated Zone TOT Category (Step 3) and Timeframe (Step 1).

Saturated Zone Likelihood (L_S) = ____ ____ ____

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Step 5 Compute Likelihood of Reaching the Well (L_2)

Set

$$L_2 = L_U \text{ (Step 4)} + L_3 \text{ (Step 4)}$$

Note: As the Likelihood of Reaching the Well (L_2) score becomes very low (i.e., less than -10), the estimated risk approaches a negligible value.

	CONTAMINANT		
	1	2	3
Likelihood of Reaching the Well (L_2) =	____	____	____

Step 6 Determine Unsaturated Zone Attenuation (A_U)

Use the following table to determine the Unsaturated Zone Attenuation (A_U) as a function of the Depth to Aquifer score (WD2), the Hydraulic Conductivity score (Step 2), and Contaminant Persistence (SD). For example, if the Depth to Aquifer Score is 1.5, the Hydraulic Conductivity score is 2, and the Contaminant Persistence is High, then the Unsaturated Zone Attenuation (A_U) is equal to 0.

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Unsaturated Zone Attenuation Scores (A_U)

Hydraulic Conductivity Score	Contaminant Persistence	Depth to Aquifer Score			
		0.3	1.0	1.5	2.2
1	L	-100	-100	-100	-100
	M	-6	-31.2	-94.8	-100
	H	-0.2	-1.2	-3.6	-12.0
2	L	-100	-100	-100	-100
	M	-0.1	-0.3	-0.9	-3.1
	H	0	0	0	-0.1
3	L	-0.2	-1.2	-3.6	-12.0
	M	0	0	0	0
	H	0	0	0	0
4	L	0	0	0	-0.1
	M	0	0	0	0
	H	0	0	0	0

Note: If the Hydraulic Conductivity Score is 5, then A_U is equal to 0 (regardless of the contaminant persistence and depth to aquifer scores).

CONTAMINANT

	1	2	3
Unsaturated Zone Attenuation (A_U) =	____	____	____

TRANSPORT WORKSHEET (continued)

STEP	INSTRUCTIONS	SCORE

Step 7 Compute Saturated Zone Attenuation (A_s)

Use the table on the next page to determine the Unadjusted score as a function of the Saturated Zone Material (WD6), the Distance score (SD), the Velocity score (Step 2), and Contaminant Persistence (SD). For example, if the Saturated Zone Material is Sand, the Design score is 2, the Velocity score is 3, and the Contaminant Persistence is High, then the Unadjusted score is equal to -0.6.

Then set

A_s = Unadjusted score (from table)
- Aquifer Thickness score (WD3).

You must subtract the Aquifer Thickness score from the Unadjusted score to determine A_s.

	CONTAMINANT		
	1	2	3
Saturated Zone Attenuation (A_s) =	____	____	____

Step 8 Compute Attenuation Due to Transport (A)

Set

$A = A_U$ (Step 6) + A_s (Step 7).

Note: Low values of the Attenuation Due to Transport score (A) generally cause the Potential Severity of Well Contamination to be relatively small. For a value less than -1.0, the potential Severity of Well Contamination generally is negligible.

	CONTAMINANT		
	1	2	3
Attenuation due to Transport (A) =	____	____	____

Unadjusted Saturated Zone Attenuation Scores

Saturated Zone Material

VS	CP	SILT						SAND						GRAVEL						KARST					
		Distance Score						Distance Score						Distance Score						Distance Score					
		1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
2	L	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100
	M	-2.0	-10.0	-22.0	-45.8	-100	-100	-2.3	-10.2	-22.3	-46.1	-100	-100	-2.7	-10.6	-22.6	-46.4	-100	-100	-3.8	-11.9	-23.9	-47.7	-100	-100
	H	1.8	1.3	0.7	-0.3	-3.3	-8.0	1.6	0.9	0.4	-0.7	-3.7	-8.3	1.2	0.6	0.0	-1.0	-4.0	-8.7	0.0	-0.5	-1.1	-2.1	-8.1	-9.8
3	L	-15.1	-45.7	-91.5	-100	-100	-100	-15.4	-46.0	-91.8	-100	-100	-100	-15.7	-46.3	-92.6	-100	-100	-100	-1.8	-15.0	-47.6	-93.4	-100	-100
	M	0.0	-0.3	-0.6	-1.0	-1.9	-3.3	-0.3	-0.7	-0.9	-1.4	-2.3	-3.6	-0.7	-1.0	-1.3	-1.7	-2.6	-4.0	-1.8	-2.1	-2.4	-2.8	-3.7	-5.1
	H	0.0	-0.2	-0.4	-0.5	-0.8	-1.0	-0.3	-0.6	-0.7	-0.9	-1.2	-1.3	-0.7	-0.9	-1.1	-1.2	-1.5	-1.7	-1.8	-2.0	-2.2	-2.3	-2.6	-2.8
4	L	-2.1	-2.7	-3.3	-4.3	-7.3	-11.9	-2.3	-3.1	-3.6	-4.7	-7.7	-12.2	-2.7	-3.4	-4.0	-5.0	-8.0	-12.5	-3.8	-4.5	-5.1	-8.1	-891	-13.7
	M	-2.0	-2.2	-2.4	-2.5	-2.7	-2.9	-2.3	-2.6	-2.7	-2.9	-3.1	-3.2	-2.7	-2.9	-3.1	-3.2	-3.4	-3.6	-3.8	-4.0	-4.2	-4.3	-4.5	-4.7
	H	-2.0	-2.2	-2.4	-2.5	-2.7	-2.9	-2.3	-2.6	-2.7	-2.9	-3.1	-3.2	-2.7	-2.9	-3.1	-3.2	-3.4	-3.6	-3.8	-4.0	-4.2	-4.3	-4.5	-4.7
5	L	-4.0	-4.2	-4.4	-4.5	-4.8	-5.0	-4.3	-4.5	-4.7	-4.9	-5.2	-5.3	-4.7	-4.9	-5.1	-5.2	-5.5	-5.7	-5.8	-6.0	-6.2	-6.3	-6.6	-6.8
	M	-4.0	-4.2	-4.4	-4.5	-4.7	-4.9	-4.3	-4.6	-4.7	-4.9	-5.1	-5.2	-4.7	-4.9	-5.1	-5.2	-5.4	-5.6	-5.8	-6.0	-6.2	-6.3	-6.5	-6.7
	H	-4.0	-4.2	-4.4	-4.5	-4.7	-4.9	-4.3	-4.6	-4.7	-4.9	-5.1	-5.2	-4.7	-4.9	-5.1	-5.2	-5.4	-5.6	-5.8	-6.0	-6.2	-6.3	-6.5	-6.7

Note: VS = Velocity Score, CP = Contaminant Persistence

If the velocity score is 1, then the Unadjusted Saturated Zone Attenuation Score is equal to -100 (regardless of contaminant persistence, saturated zone material and distance score).

TECHNICAL APPENDIX A: ASSUMPTIONS AND LIMITATIONS OF THE PRIORITY SETTING APPROACH

The Priority Setting Approach incorporates many assumptions. This appendix discusses the major assumptions regarding aquifer physical properties, zone of contribution, potential contamination sources, toxicity of contaminants or contaminant mixtures, and dense and light non-aqueous phase liquids. It also provides a summary of the effects on the risk scores if these assumptions vary from actual field settings.

Aquifer Physical Properties

The theoretical basis of this Approach's transport component includes two elements: (1) the Darcy flow law to describe the movement of contaminants from the source to the aquifer in the unsaturated zone and (2) an analytical two-dimensional transport model (developed by Wilson and Miller) to describe the movement of contaminants in the saturated zone from directly below the source to the wellhead.

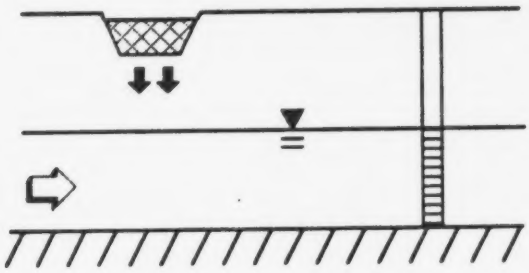
Several basic hydrogeologic settings can be reasonably evaluated using the Priority Setting Approach, as presented in Exhibit A-1. In Setting 1, contamination from the source is released into an unconfined (water table) aquifer and is intercepted by a well in the same aquifer. In Setting 2, contamination results from the failure in a confined aquifer of the casing of a Class I, II, or III injection well. This contamination is then intercepted by a well drawing water from the same confined aquifer. Setting 3 involves a contamination source in a recharge zone for a confined aquifer that is in direct hydraulic connection with the ground surface. This situation occurs if the confining layer is relatively thin or absent in the recharge zone. In Setting 4, the aquifer is overlain by a fine-grained clay that serves as a confining layer. In wells that penetrate the confining layer into the aquifer, the water level rises above the aquifer. This water level reflects the potentiometric surface of the aquifer. In this case, users should be careful to use the distance from the source to the top of the confined aquifer, and not to the potentiometric surface, as the depth to aquifer when completing the Wellhead Datasheet.

This Approach is designed to evaluate potential sources of contamination in a single aquifer-single well system. To evaluate a composite hydrogeologic setting using this Approach, each aquifer and its associated contamination sources must be considered separately.

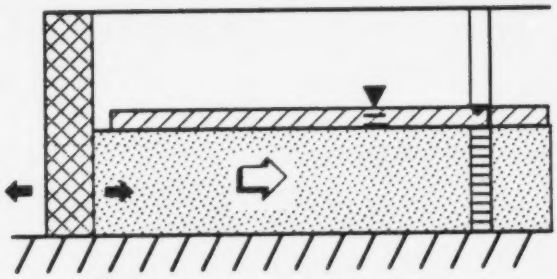
Exhibit A-1

Hydrogeologic Settings that Can Be Evaluated with the Priority Setting Approach

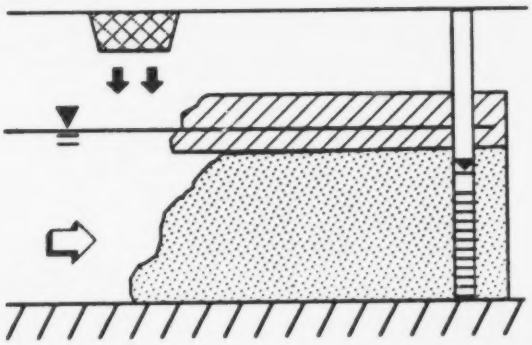
Setting 1. Surface Contamination Source-Unconfined (Water Table) Aquifer



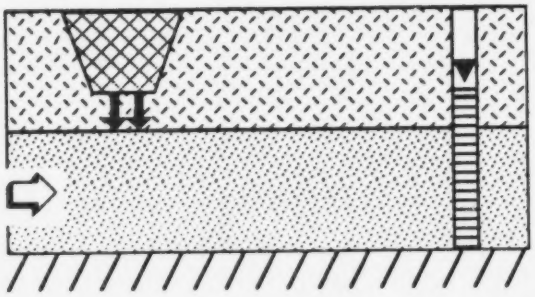
Setting 2. Deep Source-Confined Aquifer

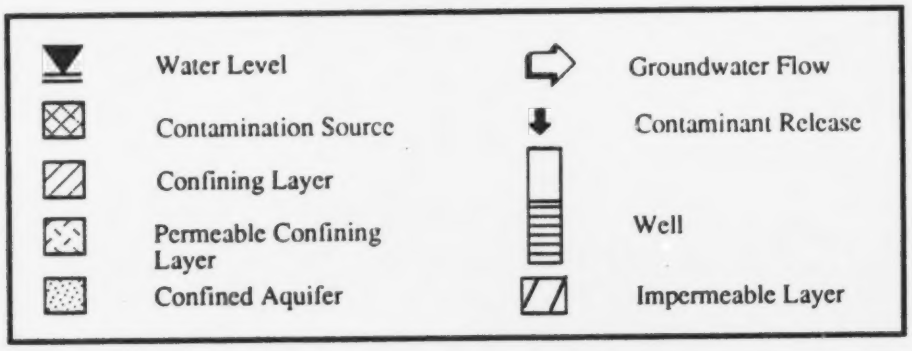


Setting 3. Surface Source in Recharge Area- Confined Aquifer



Setting 4. Surface Source-Confined Aquifer





This Approach assumes homogeneity and isotropy of the hydrogeologic system within the WHPA. In particular, it assumes that the hydrogeologic parameters are uniform throughout the WHPA,[1] that uniform and steady flow prevails, and that the aquifer is of infinite extent. This implies that the thickness and flow rate in the unsaturated and saturated zones are constant. Moreover, the flow velocity in the aquifer is assumed to reflect both the effects of the regional hydraulic gradient and pumping stresses, and is set to an average constant for the entire WHPA.

This Approach provides default hydraulic conductivity values as a function of the type of material (e.g., sand or clay); these defaults do not vary between the saturated and unsaturated zones. Default flow velocities are based upon a unit hydraulic gradient and an average porosity of 0.3. This requires that the effect of drawdown near the well in an unconfined aquifer be relatively small compared to the saturated thickness. Consequently, it is assumed that pumping rates are not so excessive so as to completely dewater even a fine-grained aquifer. If the user does not know the pumping rate in an aquifer consisting primarily of sand, then he or she should select the appropriate ground-water velocity score from Table W.4. Finally, it is assumed that wells fully penetrate the aquifer.

Zone of Contribution

WHPAs can be delineated using a variety of techniques ranging from simple, somewhat arbitrary graphical techniques to complicated methods based upon analytic or numerical modeling. In practice, the WHPA boundary may coincide with a ground-water divide, lithologic boundary, or even a jurisdictional border. This Approach assumes that the boundaries of a WHPA are contained within the zone of contribution, as described in the Office of Ground Water and Drinking Water's "Delineation of Wellhead Protection Areas." Depending on how the WHPA has been delineated, there may exist contamination sources in the zone of contribution that are not located inside the WHPA. If you know of such sources, you may want to evaluate them in addition to sources located inside the WHPA.

[1] The Darcy flow law and Wilson and Miller model consider the following major parameters: vertical distance from the contamination source to the top of the aquifer, unsaturated hydraulic conductivity, longitudinal distance from the contamination source to the wellhead, aquifer flow velocity, porosity, and transverse dispersivity (a measure of how fast contamination spreads in the direction perpendicular to the prevailing ground-water direction).

Contamination Sources

The Priority Setting Approach also makes assumptions about the physical and chemical characteristics of the sources of potential contamination. For example, it is assumed that the contamination is in the form of an aqueous solution having the same density and viscosity as water. It is further assumed that constituent concentrations do not vary with time. The transport model considers each source as a point source and assumes that concentrations do not vary in the vertical dimension. Retardation coefficients and biodegradation rates are also assumed to be constants that are not affected by concentration or by mixture with other constituents. Leakage from a contamination source is assumed to influence neither the shape of the water table nor the prevailing ground-water velocity. Finally, this Approach assumes that the contamination at the wellhead is not diluted from capture of "clean water" during pumping.

Toxicity of the Contaminant

Toxicity of the contaminant indicates the potential health hazard posed by ingesting the contaminant. The Toxicity scores are based on established dose-response relationships obtained from EPA's Integrated Risk Information System (IRIS) or from the RASH database (only for a few contaminants). Using these dose-response relationships, a "critical dose" is defined for each contaminant, which represents the dose at which health risks become of concern.

Because carcinogens and non-carcinogens act differently on the body, the critical dose is defined differently for each of them (note that the Priority Setting Approach does not address microbiological contaminants). For non-carcinogens, the critical dose is defined as the EPA-defined oral reference dose (RfD), which is the threshold exposure level at which health effects begin to occur. For carcinogens, it is generally assumed that no threshold levels exist because any level can cause cancer. Therefore, for carcinogens, the critical dose is defined as the dose that increases the risk of cancer by 10^{-5} over background levels; i.e., an excess cancer risk of 1 in 100,000. This Approach converts these critical doses into critical concentrations (in milligrams per liter of drinking water) using standard Office of Ground Water and Drinking Water assumptions (i.e., two liters consumed per day over a 70-year lifetime exposure period).

Toxicity of the contaminant is defined as the decimal logarithm of the inverse of the critical concentration in mg/l. Thus, the Toxicity Score T has units of $\log_{10}(1/(mg/l))$. You read the Toxicity score T directly from a concentration scoring graph (end of Form S.1) or a table (Form S.2).

Because the health risks posed by carcinogens and non-carcinogens are very different, as are the methods used to define these risks, many users may prefer to track them separately. If you choose to produce only one screening and ranking of all sources, then you can consider both carcinogens and non-carcinogens together. In this case, the Priority Setting Approach has

a built-in formula for comparing carcinogenic and non-carcinogenic risks. As discussed previously, this Approach implicitly equates a 10^{-5} lifetime cancer risk to a lifetime exposure to the reference dose (RfD) for non-carcinogens. You can alter this assumption to reflect different policy calls. For example, you can choose to equate a 10^{-6} lifetime cancer risk to a lifetime exposure to the reference dose (RfD) for non-carcinogens. In this case, you should add a 1 to all the risk scores for carcinogenic contaminants as computed in Task V, Step 1. If you choose to equate a 10^{-4} lifetime cancer risk to a lifetime exposure to the reference dose (RfD) for non-carcinogens, then you should subtract a 1 from all the risk scores for carcinogenic contaminants.

Dense and Light Non-Aqueous Phase Liquids (DNAPLs and LNAPLs)

Dense non-aqueous phase liquids (DNAPLs), also known as sinkers, and light non-aqueous phase liquids (LNAPLs), also known as floaters, are ground-water contaminants that are relatively insoluble in water and have densities greater than and less than water, respectively. Due to their density and limited solubility in water, DNAPLs and LNAPLs can pose special risks to ground-water quality. If released in large quantities, these liquids can migrate vertically under the influence of gravity (i.e., sink to the bottom of the saturated zone if a DNAPL or float on the water table if an LNAPL) and act as a highly concentrated, long-term source of contamination.

The Priority Setting Approach allows you to recognize DNAPLs and LNAPLs in two stages. First, contaminant Form S.1 notes those contaminants that are potential DNAPLs or LNAPLs (see Task II, Step 5). Second, this Approach provides a rule of thumb for determining whether a potential DNAPL or LNAPL will act as a true DNAPL or LNAPL based on the quantity of the contaminant released. Specifically, a potential DNAPL or LNAPL will act as a true DNAPL or LNAPL if the Quantity score for that contaminant is greater than or equal to 3; that is, if the contaminant is released at an annual rate of 1,000 kg per year or more (see Task III, Step 6).

The Transport Worksheet does not model the fate and transport phenomena specific to DNAPLs and LNAPLs. These liquids follow different transport patterns from other common contaminants because they are denser or lighter and more or less viscous than water. As a result, they tend to sink to the impervious base of the saturated zone (for DNAPLs) or float on top of the water table (for LNAPLs). For example, because DNAPLs tend to move along impervious layers of soils or rock, they will move away from a drinking water well if the impervious layer is tilted away from the well. In this case, the Priority Setting Approach will overestimate the risk posed by a DNAPL. Because of the complexity of the transport phenomena involved, however, this Approach does not provide guidance on whether the Risk scores will be over-estimated or under-estimated in the case of DNAPLs or LNAPLs.

Therefore, this Approach does not apply to potential DNAPLs or LNAPLs with a Quantity score of 3 or more.

NOTE: DNAPLS and LNAPLs can be a serious threat to wellheads and are extremely difficult to remove from the water supply once contamination occurs. If you believe a DNAPL or LNAPL is present in the water supply or threatens a wellhead, you should pay special consideration to this threat.

Validity of the Risk Estimates Under Field Conditions that Diverge from the Priority Setting Approach Assumptions

Exhibit A-2 presents a summary explanation of the effects on the accuracy of the Risk scores if you diverge from the assumptions summarized in this appendix. The first column lists field conditions that differ from the conditions assumed in this Approach. The second column notes the effects on the risk estimates as a result of diverging from the model conditions.

For example, this Approach assumes that contaminants flow in a straight line between a source and a well. If a source is not directly upgradient, the contaminant flow path will most likely not be a straight line. In this Approach, such sources are called "off-center" sources. The Priority Setting Approach over-estimates the risks posed by an off-center source because it underestimates the travel time of the contaminants from such sources. Note that in some instances, it is not possible to say whether the Priority Setting Approach will overestimate or underestimate risks. For example, for DNAPLs or LNAPLs, it may overestimate or underestimate risks depending on a number of factors not modeled in this Approach (see the discussion above on DNAPLs and LNAPLs).

Exhibit A-2

Validity of the Risk Estimates Under Field Conditions that Diverge from the Priority Setting Approach's Assumptions

Field Condition	Effect of Field Condition Upon Accuracy of Risk Estimate
Non-uniform aquifer thickness	Overestimate/Underestimate - depends on downgradient trend
Spike release at source	Overestimate/Underestimate - depends on distance to source and flow velocity
Seasonal pumping cycle	Overestimate
Areal source	Overestimate/Underestimate - depends on relative proximity of source to wellhead
Dense non-aqueous phase liquids (DNAPLs)	Overestimate/Underestimate - depends on density, viscosity, quantity, and surface tension of contaminant
Light non-aqueous phase liquids (LNAPLs)	Overestimate/Underestimate - depends on density, viscosity, quantity, and surface tension of contaminant
Partial penetration of well	Overestimate
Contaminant dispersion in unsaturated zone	Overestimate
Dilution at wellhead	Overestimate
Off-center source	Overestimate
Anisotropy	Overestimate/Underestimate - depends on relative position of source and well

TECHNICAL APPENDIX B: CONCEPTUAL OVERVIEW OF THE PRIORITY SETTING APPROACH

The Priority Setting Approach is a simple tool that allows the manager of a WHPA to assess the risks posed by potential sources of wellhead contamination. This appendix presents a general overview of the Approach's framework, describes the two components of risk in this Approach, and reviews how risk is computed as a function of these two risk components.

Overview of the Priority Setting Approach's Framework

The Priority Setting Approach is applied through a set of step-by-step worksheets. The user is led through a series of simple computations to calculate the risk posed by each potential contamination source within a WHPA. This section describes how this Approach emulates a human health risk assessment using simple, yet meaningful additive risk scores.

The Priority Setting Approach Emulates a Conventional Human Health Risk Assessment

The Priority Setting Approach is based on a simplified version of a conventional human health risk assessment. A conventional human health risk assessment generally answers two basic questions: (1) what is the frequency/duration of the exposure to a substance? and (2) what is the degree of toxicity of the substance? For the purposes of this Approach, the exposure and toxicity coefficients equate to: (1) What is the probability that something will go wrong? and (2) What are the consequences in the event something does go wrong?

This Approach considers two components of risk. For a given contaminant or contaminant mixture present at a potential contamination source, the user estimates a Risk score as the sum of two risk components:

(1) Likelihood of well contamination; that is, the likelihood that the contaminant will be released from that source and will reach the well within a specified period of time.

(2) Severity of well contamination; that is, the potential health hazard from drinking water drawn from the well that has been polluted by that

contaminant, taking into account contaminant dilution and dispersion between the source and the wellhead.

The Overall Risk score for a given source of potential contamination is the highest of the Risk scores associated with each contaminant or contaminant mixture present at the source.

Scoring Is Based on Logarithmic Conversion of Natural Units

The algorithms used in this Approach reflect the "natural units" of each risk parameter. For example, contaminant releases are expressed as mass released per unit of time (kg/yr), while contaminant concentrations are measured as mass unit per unit volume of water (kg/m^3). In addition, the risk parameters are functionally related within this Approach in the same manner that they are in a conventional human health risk assessment. The reliance on natural units of measurement and natural functional relationships ensures that the scores are non-arbitrary. That is, each variable is assigned its natural "weight" in terms of its contribution to the final Risk score.

The functional products of a conventional risk assessment are generally derived by multiplying several individual parameters to determine risk assessments. To ensure relative ease of use of this Approach without compromising on the rigor of a conventional risk assessment, the Priority Setting Approach assumes a conversion of the basic product (derived risk values) using the decimal logarithmic function. As a result, individual parameters generally are summed rather than multiplied to obtain risk scores.

The implicit use of decimal logarithmic conversion is best illustrated by the following example. The quantity of contaminant released annually (in kg/yr) is equal to the product of the volume of "waste" released annually (in m^3/yr = 1,000 l/yr) times the contaminant concentration in waste (in kg/m^3 = 1,000 ppm = 1,000 mg/l). Using the decimal logarithmic conversion, the Quantity score ($\log_{10}(kg/yr)$) is computed as the sum of the Volume score ($\log_{10}(m^3/yr)$) plus the Concentration score (in $\log_{10}(kg/m^3)$). That is, if 1 million liters of a solution containing benzene at a concentration of 1,000 ppm are released annually, then the Quantity score is equal to 3: i.e., 3 for the Volume score (i.e., $\log_{10}(1{,}000\ m^3/yr)$) plus 0 for the Concentration score (i.e., $\log_{10}(1kg/m^3)$), which means that 1,000 kilograms of benzene are released annually).

Likelihood of Well Contamination

Likelihood of well contamination gives the probability that a source contaminant will reach the well within a user-specified time horizon, referred to as the Planning Period. As described in this section, for a given contaminant or contaminant mixture at a given source of potential contamination, Likelihood of well contamination is the sum of two partial risk scores: the Likelihood of release at the source and the Likelihood that the contaminant will reach the well.

Likelihood of Release at the Source (L_1)

Likelihood of release at the source (L_1) reflects the likelihood of an average-sized release of a contaminant from a source. L_1 is a function of the source type and is based on engineering failure analyses that account for the type of potential contamination source (e.g., landfills versus tanks). It is also a function of design characteristics (e.g., number and type of liners at a landfill) and operating status (e.g., age), as appropriate. For example, the L_1 values for tanks are a function of tank design (one of 12 designs in the Priority Setting Approach) and tank age, and are derived from the Hazardous Tank Failure Model (ref. 12).

To derive the L_1 score, refer to the tables in the Source Worksheets, which provide the L_1 score as a function of input parameters such as the age, design, and status of a specific source. Higher values of L_1 indicate a greater likelihood of release. For example, an L_1 score of 0 corresponds to a probability of 1 (i.e., 100 percent chance of release), while an L_1 score of -3.5 corresponds to a lower probability of 0.0032.

Likelihood that the Contaminant Released Will Reach the Well (L_2)

This partial risk score reflects the probability that the contaminant will reach the well within the Planning Period, assuming that the contaminant is released from the source starting from day one in the source's lifetime. The Transport Worksheet derives the Likelihood of reaching the well (L_2) by comparing (1) the time of travel of the contaminant from the source to the well, to (2) the sum of the source age plus the Planning Period.

For simplification, the L_2 score is approximated as the sum of two scores: L_U for the unsaturated zone and L_S for the saturated zone. The L_U score is based on the time of travel of the contaminant through the unsaturated zone in comparison to the Planning Period. Likewise, the L_S score is based on the time of travel through the saturated zone to the well in comparison to the Planning Period.

For a given contaminant, the time of travel through the unsaturated zone (TOT_U) is given by Darcy's law as a function of the depth to the aquifer, the hydraulic conductivity of the unsaturated zone, and the contaminant mobility. If all parameters could be estimated with precision, the question "will the released contaminant cross the unsaturated zone within the Planning Period?" could be answered simply "yes" or "no." That is, the probability that the contaminant will cross the unsaturated zone within the Planning Period is either zero (i.e., $L_U = -\infty$) if TOT_U is less than the Planning Period, or one (i.e., $L_U = 0$) if TOT_U is greater than or equal to the Planning Period. In this Approach, however, input parameters are estimated within ranges, and functional relationships are only approximations of the fate and transport phenomena taking place. Due to this uncertainty, this Approach computes a probability that is between zero and one, that is, a likelihood L_U that is between $-\infty$ and 0.

Likewise, for a given contaminant, the time of travel through the saturated zone (TOT_S) is a function of the distance from the source to the well, ground-water velocity, and the contaminant mobility. Because of the uncertainty and variability of these input parameters and, therefore, of the functional relationship to compute TOT_S, this Approach computes a probability between zero and one (i.e., likelihood L_S between $-\infty$ and 0) that the contaminant will cross the saturated zone to the well within the Planning Period.

You read the values of L_U and L_S from tables as a function of the above-mentioned input parameters. Then compute the Likelihood that the contaminant will reach the well (L_2) by summing L_U and L_S. Bypass the calculations of L_U and L_S and set the L_2 score equal to 0 if the source discharges directly to a conduit system (e.g., abandoned utility network) that provides a short-cut to the well for the released contaminant. L_2 values are less than or equal to 0, with higher values (approaching zero) indicating higher probabilities that the contaminant will reach the well if released.

Deriving the Likelihood of Well Contamination (L)

For a given contaminant present at a given source, the well will be contaminated within the Planning Period *if and only if* the contaminant is released from the source and reaches the well within the Planning Period. Thus, the probability of well contamination is equal to the probability of release from the source multiplied by the probability that the contaminant will reach the well within the Planning Period. Taking the decimal logarithm of these probabilities, the Likelihood of well contamination (L) is the sum of the Likelihood of release of the contaminant at the source (L_1) plus the Likelihood that the contaminant will reach the well within the planning period (L_2):

Likelihood of well contamination score (L)	=	Likelihood of release score (L_1)	+	Likelihood of reaching the well score (L_2)

The Likelihood of well contamination (L) is less than or equal to 0. The higher the value of L (i.e., the closer L is to 0), the higher the likelihood that the contaminant will be released and reach the well within the specified Planning Period.

Severity of Well Contamination

For a given contaminant or contaminant mixture at a potential source of contamination, Severity of well contamination (S) reflects the potential health hazard from drinking water from a well that has been polluted by that contaminant. As discussed in this section, Severity of well contamination (S) is the sum of three partial risk scores: the Quantity (Q) of contaminant released annually at the source, Attenuation (A) due to transport from the source to the well, and the Toxicity (T) of the contaminant.

Quantity Released at the Source (Q)

Quantity released at the source (Q) is the expected mass of contaminant or contaminant mixture released annually from a given source of potential contamination. The expected quantity of contaminant released annually (in kg/yr) is equal to the product of the annual expected volume of "waste" released (m^3/yr) times the contaminant concentration in the waste (in kg/m^3). Applying the logarithmic conversion, you compute the Quantity released score (Q) (in $\log_{10}$(kg/yr)) by adding the Volume score (represents the volume of "waste" released, in $\log_{10}$(m^3/yr)) and the Concentration score (represents the contaminant concentration in waste, in $\log_{10}$(kg/m^3)).[1]

The Source Worksheets provide tables for determining the Volume score as a function of input parameters such as facility type and size, as appropriate. You either determine the Concentration score from a graph provided in Contaminant Form S.1 as a function of the contaminant concentration (if known), or read the default, contaminant-specific Concentration score applicable to the source from Form S.2.[2] The resulting scores for Q generally range from -1 to 5, with the latter representing the largest theoretical contaminant mass release.

Attenuation Due to Transport (A)

Attenuation due to transport (A) reflects the dilution and decay of the contaminant released due to transport from the source to the well. Attenuation is defined as the contaminant concentration at the wellhead per unit of contaminant released annually at the source. Therefore, Attenuation due to transport has units of $\log_{10}$((mg/l)/(kg/yr)). Note that the Attenuation score actually reflects the lack of attenuation of the contaminant; i.e., the higher the Attenuation score, the lesser the dilution and decay of the contaminant.

The Transport Worksheet calculates the Attenuation score (A) as the sum of two Attenuation scores: one for the unsaturated zone, A_U, and one for the saturated zone, A_S. The unsaturated zone attenuation score (A_U) is a function of the unsaturated zone hydraulic conductivity, the contaminant persistence and mobility (as provided in the contaminant forms), and the depth to aquifer. It measures the ratio of the quantity of contaminant leaving the unsaturated zone to enter the saturated zone divided by the quantity of contaminant entering the unsaturated zone after being released from the source. Thus, the unsaturated zone attenuation score (A_U) has units of $\log_{10}$((kg/yr)/(kg/yr)); i.e., it is dimensionless.

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[1] This is true for all sources except agrichemical applications, where the "Volume" score is in $\log_{10}$ (hectares) and the "Concentration" score is in $\log_{10}$ (kg/hectare/yr).

[2] The Contaminant Concentration Scoring Graph in Form S.1 simply converts the contaminant concentration from kg/m^3 to a Concentration score in decimal logarithm.

The saturated zone Attenuation score (A_s) is a function of ground-water velocity, the contaminant persistence and mobility, the type of material in the saturated zone, and the distance from the source to the well. Using the Wilson and Miller equation to model the fate and transport of contaminants in the saturated zone, this Approach provides the saturated zone Attenuation score (A_s) in units of $\log_{10}((mg/l)/(kg/yr))$.

You derive the Attenuation score (A) by working through a series of tables that factor in the relevant parameters described above. The resulting Attenuation score is generally less than 0, with higher values of the Attenuation score indicating higher contaminant concentration at the well per unit of mass released at the source. The Attenuation score thus reflects the lack of attenuation from the source to wellhead.

Toxicity of the Contaminant (T)

Toxicity of the contaminant (T) indicates the potential health hazard posed by ingesting the contaminant. The Toxicity scores (T) are based on established dose-response relationships obtained from EPA's Integrated Risk Information System (IRIS) or from the RASH database (only for a few contaminants). Using these dose-response relationships, the Priority Setting Approach defines a "critical dose" for each contaminant. The critical dose is defir as the oral reference dose (RfD) for non-carcinogens and the dose corresponding to an excess ' time risk of 10^{-5} (1 in 100,000) for carcinogens. This Approach converts these critical doses into critical concentrations (in mg/liter of drinking water) using standard Office of Ground Water and Drinking Water assumptions (i.e., two liters consumed per day over a 70-year lifetime exposure period).

Toxicity of the contaminant (T) is defined as the decimal logarithm of the inverse of the critical concentration. Thus, Toxicity (T) has units of $\log_{10}(1/(mg/l))$. You read the Toxicity score (T) directly from a simple table (in either Contaminant Form S.1 or in Form S.2). Toxicity scores (T) range from -2.4 to 3.8, with higher scores (e.g., 3.8) indicating more toxic contaminants.

Deriving the Severity of Well Contamination (S)

For a given contaminant or contaminant mixture at a given source of potential contamination, Severity of well contamination (S) is the sum of Quantity released at the source (Q), Attenuation due to transport (A), and Toxicity of the contaminant (T):

Severity =	Quantity +	Attenuation +	Toxicity
score (S)	score (Q)	score (A)	score (T)

where

S is Severity of well contamination score, dimensionless

Q is Quantity released at the source, in $\log_{10}$(kg/yr)

A is Attenuation due to transport, in $\log_{10}$[(mg/l)/(kg/yr)]

T is Toxicity of the contaminant in $\log_{10}$[1/(mg/l)].

The term (Q+A) represents the contaminant concentration at the well. Adding the term T to the term (Q+A) is equivalent to dividing the contaminant concentration at the well by the contaminant's critical concentration in drinking water. Thus, the Severity of well contamination score (S) indicates the estimated number of times the contaminant concentration at the well will vary from the contaminant's critical concentration in drinking water. For example, a Severity of well contamination score (S) of 0 means that the contaminant concentration at the well is estimated to be equal to the critical concentration. If the Severity score (S) is equal to 1, the contaminant concentration at the well is one order of magnitude (i.e., ten times) higher than the critical concentration. Conversely, a Severity score (S) of -1 indicates a contaminant concentration at the well that is one order of magnitude less than the critical concentration. The Severity scores (S) derived from the calculations can be either negative or positive, with higher values indicating greater contamination severity.

Risk of Well Contamination

This section describes how the Likelihood score (L) and Severity score (S) of well contamination are combined to derive a Risk score (R) of well contamination for each contaminant or contaminant mixture present at a given source. It then describes how the contaminant-specific Risk scores are aggregated to derive an Overall Risk score for each potential source of contamination. The difference between the Risk score (R) and the Overall Risk score is that the Overall Risk score is source-specific, whereas the Risk score is contaminant-specific.

Risk of Well Contamination Posed by a Contaminant (R)

For a given source of potential contamination, the Risk of well contamination (R) posed by a given contaminant or contaminant mixture is equal to the sum of the Likelihood of well contamination (L) and the Severity of well contamination (S):

Risk score (R) = Likelihood score (L) + Severity score (S)

In natural units, the risk of well contamination posed by a given contaminant is the product of the probability of well contamination, times the severity of well contamination. For example, if a contaminant at a potential source has a Risk score of -1, then this contaminant is expected to contaminate the well at a concentration equal to one tenth its critical concentration in drinking water.

Risk of Well Contamination Posed by a Source

The Overall Risk of well contamination posed by a given source is equal to the highest of the Risk scores (R) of well contamination posed by individual contaminant mixtures present at the source. For example, if a source has two contaminants A and B with individual Risk scores equal to -2 and -0.5, then this source has an Overall Risk score of -0.5.

You can also determine the Risk Level (i.e., Low, Medium, or High) posed by a potential source of contamination as a function of its Overall Risk score. If the Overall Risk score is less than -4, then the source poses a Low level of risk. If the Overall Risk score is greater than 0, then the source poses a High risk level. If the source has an Overall Risk score between -4 and 0, then it poses a Medium risk of well contamination. In this case, the contaminant is expected to contaminate the well with a concentration of between 1/10,000th its critical concentration and its critical concentration.

Plotting Contaminants and Sources on the Risk Matrix

The Risk Matrix allows you to visualize the risks posed by either individual contaminants or contaminant mixtures at a source or the Overall Risks posed by individual sources within the WHPA. You will plot individual contaminants and the sources based on their Likelihood (L) and Severity (S) scores. Sources of contamination are plotted based on the Likelihood (L) and Severity (S) scores of the contaminant with the highest Risk score (R).

The Risk Matrix is divided into three regions corresponding to the three Risk Levels: Low, Medium, and High. The lines separating two adjacent regions in the matrix represent equal Risk scores (as the Likelihood score (L) goes down, the Severity score (S) goes up by an equal amount to maintain the Risk score (Risk = L + S)).

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ACRONYMS, SYMBOLS, AND DEFINITIONS

ACRONYMS

DNAPL	dense non-aqueous phase liquid
IRIS	Integrated Risk Information System (an EPA toxicity database)
LNAPL	light non-aqueous phase liquid
SWDA	Safe Water Drinking Act
TOT	time-of-travel (of a chemical released in the wellhead area)
WD	used in this manual to mean the Wellhead Datasheet
WHPA	Wellhead Protection Area

SYMBOLS

A	Attenuation of the contaminant due to transport
A_S	Attenuation of the contaminant in the saturated zone
A_U	Attenuation of the contaminant in the unsaturated zone
L	Likelihood of well contamination
L_1	Likelihood of contaminant release at the source
L_2	Likelihood of reaching the well if contaminant release occurs
L_S	Likelihood of transport through the saturated zone
L_U	Likelihood of transport through the unsaturated zone to the saturated zone
Q	Quantity of contaminant expected to be released at the source
S	Severity of potential well contamination
T	Toxicity of the contaminant

DEFINITIONS[1]

Anisotropy - the condition of having different properties when measured along axes in different directions. See its antonym - **Isotropy.**

Aquifer - a formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Attenuation - to reduce, weaken, dilute, or lessen in severity, value, or amount such as the attenuation of contaminants as they migrate from a particular source. In the context of the Priority Setting Approach, the Attenuation score actually reflects the lack of attenuation of the contaminant; i.e., the higher the Attenuation score, the lesser the dilution and decay of the contaminant.

Cone of Depression - A depression of the potentiometric surface in the shape of an inverted cone that develops around a well which is being pumped.

Confined aquifer - an aquifer bounded above and below by confining units of distinctly lower permeability than that of the aquifer itself.

Contaminant - an undesirable substance not normally present or an unusually high concentration of a naturally occurring substance in water or soil.

Contamination - the addition to water of contaminants, preventing the use or reducing the usability of the water. Sometimes considered synonymous with pollution.

Darcy's law - an empirical law that states that the velocity of flow through a porous medium is directly proportional to the hydraulic gradient under certain assumptions.

Drainage well - a well installed to drain surface water, storm water, or treated waste water into underground strata.

Flow, steady - a characteristics of a flow system where the magnitude and direction of specific discharge are constant in time at any point.

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[1] Terms and definitions from (1) U.S. Department of Interior, U.S. Geological Survey, *Federal Glossary of Selected Terms: Subsurface Water Flow and Solute Transport*, Reston, Virginia, 1989, (2) U.S. Environmental Protection Agency, Office of Emergency Response, *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*, Washington, D.C., 1986, (3) U.S. Environmental Protection Agency, *Guidance for Applicants for Wellhead Protection Program Assistance Funds under the Safe Water Drinking Act*, 1987, and (4) 40 CFR Section 144.6.

Flow, unsteady - a characteristics of a flow system where the magnitude and/or direction of specific discharge changes with time.

Ground water - that part of the subsurface water that is in the saturated zone.

Ground-water flow - the movement of water in the zone of saturation.

Ground-water recharge - the process of water addition to the unsaturated zone or the volume of water added by this process.

Ground-water velocity - see velocity, interstitial.

Heterogeneity - a characteristics of a medium in which material properties vary from point to point.

Homogeneity - a characteristic of a medium in which material properties are identical everywhere.

Hydraulic conductivity - the volume of water that will move through a medium in a unit of time under a unit hydraulic gradient through a unit area measured perpendicular to the direction of flow. See also unsaturated flow.

Hydraulic gradient - slope of the water table or potentiometric surface.

Hydrogeology - the science dealing with the occurrence of groundwater, its utilization, and its functions.

Hydrologic properties - those properties of a rock that govern the entrance of water and the capacity to hold, transmit, and deliver water, such as porosity, effective porosity, specific retention, permeability, and the directions of maximum and minimum permeabilities.

Impermeable - a characteristic of some geologic material that limits its ability to transmit significant quantities of water under the head differences ordinarily found in the subsurface.

Infiltration - the downward entry of water into the soil or rock. **Net infiltration** - the amount of rain, melting snow, or surface water, minus evaporation and plant transpiration, that enters into the soil or rock.

Injection well - a well into which fluids are being injected. The different kinds of injection wells are:

Class I: Wells used to inject liquid hazardous wastes or dispose of industrial and municipal waste waters beneath the lower-most underground source of drinking water (USDW).

Class II: Wells used to dispose of fluids associated with the production of oil and natural gas (hydrocarbons), to inject fluids for enhanced oil recovery, or for the storage of liquid hydrocarbons.

Class III: Wells used to inject fluids for the extraction of minerals (i.e., solution mining).

Class IV: Wells used to dispose of hazardous or radioactive wastes into or above a USDW. The USEPA has banned the use of these wells.

Class V: Wells not included in the other classes and generally used to inject nonhazardous fluid into or above a USDW.

Isotropy - the condition in which the property or properties of interest are the same when measured along axes in any direction.

Non-point source - a source originating over broad areas, such as areas of fertilizer and pesticide application and leaking sewer systems, rather than from discrete points.

Permeability - the property of a porous medium to transmit fluids under an hydraulic gradient.

Point source - any discernable, confined, or discrete conveyance from which contaminants are or may be discharged, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, container, rolling stock, or concentrated animal feeding operation.

Porosity, effective - the ratio, usually expressed as a percentage, of the total volume of voids available for fluid transmission to the total volume of the porous medium.

Potentiometric surface - an imaginary surface representing the static head of groundwater and defined by the level to which water will rise in a tightly cased well.

Pumping rate - the rate at which ground water is pumped from an aquifer.

Recharge area - an area in which water reaches the zone of saturation by surface infiltration.

Reference dose - for non-carcinogens, the exposure threshold above which health effects begin to occur.

Retardation factor - the ratio of the average linear velocity of ground water to the velocity of the retarded constituent.

Saturated zone - that part of the earth's crust beneath the regional water table in which all voids, large and small, are filled with water under pressure greater than atmospheric.

Solubility - the total amount of solute species that will remain indefinitely in a solution maintained at constant temperature and pressure in contact with the solid crystals from which the solutes were derived.

Transport - conveyance of solutes and particulates in the unsaturated or saturated zone.

Unconfined aquifer - an aquifer that has a water table.

Unconfined ground water - water in an aquifer that has a water table.

Unsaturated flow - the movement of water in a porous medium in which the pore spaces are not filled to capacity with water.

Unsaturated zone - the zone between the land surface and the regional water table. Generally, water in this zone is under less than atmospheric pressure, and some of the voids may contain air or other gases at atmospheric pressure.

Utility chase - a trench or channel used to house water, gas, electricity, or sewer lines, or other such underground utility lines.

Velocity, average interstitial - the average rate of ground-water flow in interstices expressed as the product of hydraulic conductivity and hydraulic gradient divided by the effective porosity.

Water table - upper surface of a zone of saturation, where the body of ground water is not confined by an overlying impermeable zone.

Well - a bored, drilled, or driven shaft, or a dug hole, whose depth is greater than the largest surface dimension.

Wellfield - one or more wells in the same general area containing a distribution system.

Wellhead - the portion of a well that extends above ground.

Wellhead Protection Area - the surface and subsurface area surrounding a water well or wellfield, supplying a public water system through which contaminants are likely to move toward and reach such well or wellfield.

Zone of contribution - all areas that recharge or contribute water to a well or well field.